Clinical Application of Orthodontic Mini-implant

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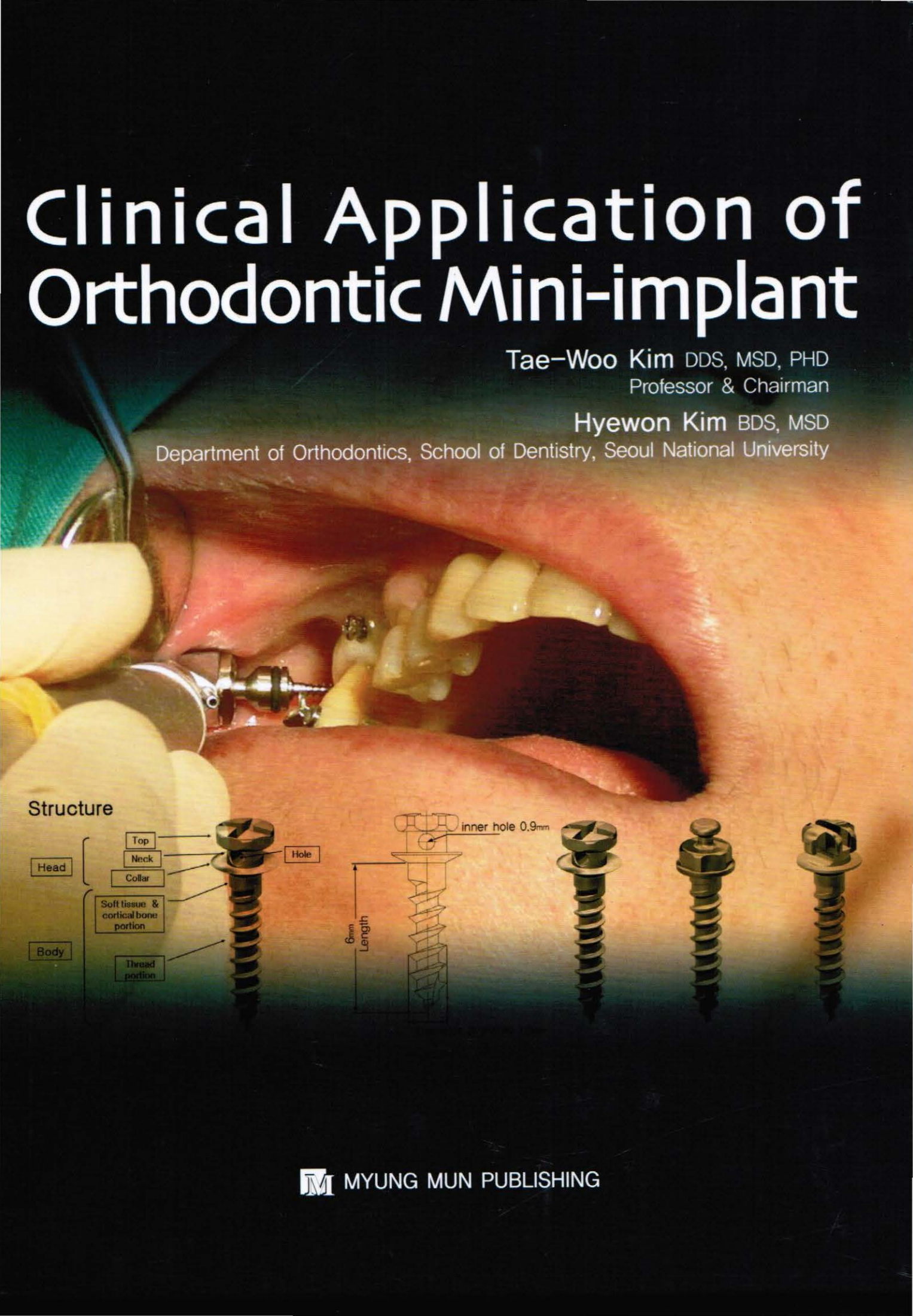

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VISIT…

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Preface

In 2002, I had the honor of being invited as a keynote speaker at the 37th Indian Orthodontic Conference (Lucknow, India). Since beginning my lectures on mini-implants at this meeting, many orthodontists have been eager to learn mini-implant techniques. Those that attended these lectures also requested relevant literature on the topic. The many teams that have gone through short term training at our department have also asked for references which are practically useful. After giving a special lecture at the 2007 American Association of Orthodontists Annual Meeting (Photo 1), I was invited to speak at 7 Orthodontic Departments of dental schools in the United States. It was here also that I was asked for material that contained actual clinical tips on mini-implant use.

This textbook contains material from those lectures, with the theoretical part kept to a minimum and concentrated more on step-by-step techniques of clinical mini-implant use. I have treated all the cases contained in this book, and the most representative cases from the lecture series were selected. These cases are all inclusive, beginning from diagnosis and treatment methods, to the actual techniques needed for mini-implants. These cases include not only the actual mini-implant techniques, but also full diagnosis and treatment methods, which will invariably become a useful learning textbook.

As I have written all pages from beginning to end, and personally edited each photograph, I present this book with much fondness and hope that it will be a helpful aid to many orthodontists.

I thank God, and give special thanks to my wife who wordlessly helped me through the many late nights at the office for the last few months.

Tae-Woo Kim

5th September 2008

Profile

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Title

- Chairman and Professor, Department of Orthodontics, School of Dentistry, Seoul National University
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- Editorial Review Board, American Journal of Orthodontics and Dentofacial Orthopedics (2003~present)
- Editorial Board, Orthodontics and Craniofacial Research, U.S.A.(2001~)
- Reviewer, World Journal of Orthodontics (Korean edition)
- Editorial Board, Korean Journal of Clinical Orthodontics
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⚜ Lectures regarding mini-implants given overseas at major conferences ⚜

2002 The 37th Indian Orthodontic Conference (Lucknow, India)

2003 Peking University (Peking,China); American Association of Orthodontists Annual Meeting

2004 European Orthodontic Conference (Denmark); The 3rd Asian Implant Orthodontics Conference Taiwan; Association of Orthodontists, Health Science University of Mongolia; Malaysian Association of Orthodontists.

2005 The 4th International Congress of Iranian Association of Orthodontists (I. A. O); Malaysian Association of Orthodontists; Indonesia; Health Science University of Mongdia; Chinese Orthodontic Society; Korean Association of Orthodontists.

2006 Malaysian Association of Orthodontists; The second annual BU Orthodontic Implant Symposium (Boston University, USA); 5th Asian Implant Orthodontic Conference (Japan); Thailand Orthodontic Conference; Health Science University of Mongolia.

2007 American Association of Orthodontists Annual Meeting; University of Washington; UCLA; USC; University of Nevada Las Vegas(UNLV); University of Colorado; Montefiore Medical Center; Vanderbilt University; University of Alabama; The 50th Anniversary annual meeting Chu-Shikoku Orthodontic Society (Okayama, Japan); World Edgewise Orthodontic Conference.

1

2

3

Photo 1, 2 ››› The author giving a lecture at the American Association of Orthodontists Annual Meeting in Seattle (19th May 2007)

Photo 3 ››› With the participants at a two-day workshop given prior to the Malaysian Association of Orthodontists (25-26th April 2006)

Introduction

The simplest, easiest, and safest technique
Minimizing discomfort for the patient

With these aims kept in mind, the technique and materials introduced in this book were carefully chosen. The use of miniplates and techniques which require referral to oral surgeons or periodontists are out of the scope of this book. For example, systems such as the Skeletal Anchorage System which requires plate insertion by oral surgeons and periodontists have been excluded. The author' s aim is to introduce techniques which can be easily performed by the orthodontists themselves. Even the novice will easily adapt to mini-implant use if similar materials and cases introduced in this book are used.

Concise and easy explanations

Based on the cases and slides used in lectures given over the years here in Korea and overseas, this book is aimed to give the effect of listening to a lecture, which will keep the reader alert. As all material needed for diagnosis and treatment of a patient are included in the text, it will actually feel as though the reader has visited the clinic at Seoul National University Dental Hospital (SNUDH) Department of Orthodontics. Complicated theoretical explanations and references were kept to a minimum.

Sequential photographs with explanations

The reader will be able to understand that a high quality of care was planned for each case. Sequential photographs were obtained to allow any reader to follow the case.

Fun orthodontics

The photographs will easily tell how much fun the author experiences while treating patients. Cases which seemed difficult will be unraveled while carefully reading through each step of the case, and the readers too will experience the excitement of orthodontics.

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Chapter 1

Preparations for mini-implant insertion

Chapter 1 Preparations for mini-implant insertion

Ⅰ. Mini-implant types and selection

There are two mini-implant insertion methods, the drilling type where a hole is made through drilling prior to mini-implant insertion and the non-drilling type where the mini-implant is inserted directly. The author used the drilling method in the past, but after Kim et al[1,2] reported in 2005 that the non-drilling method had better bone-implant contact and initial stability, switched to the non-drilling method.

Advantages of the non-drilling method

1. Simple and fast procedure. This is the biggest advantage of the non-drilling method. Because it is so simple, when clinicians actually try this method, it will be difficult to return to the drilling method.
2. No drilling instruments are required.
3. There is no need to worry about bone heating during the drilling procedure.
4. Initial bone-implant contact is large. Orthodontic force can be applied immediately after insertion.

Disadvantages of the non-drilling method

1. When inserting into the mandible or the midpalatal area, large resistance is felt.
2. It is difficult to insert at an angle larger than 30° to the alveolar bone.

In these cases, the clinician may choose to drill at any time. That is, mini-implants designed for the non-drilling technique can be applied in all cases.

Features of the non-drilling mini-implant

Mini-implant with a diameter of 1.6mm is used. Some clinicians prefer the 1.2~1.4mm mini-implants, but it is advisable to use a 1.6mm diameter with the non-drilling method. This applies especially when mini-implants must withstand being inserted into dense bone of the mandible or the midpalatal area. This is to prevent implant fracture or bending. The 2.0mm diameter in comparison is too thick and is difficult to insert in interradicular areas.

The sharp edges of the thread and tip have been designed to be able to make a hole in the bone and be inserted on its own.

Length (Figure 1-1-3)

Three lengths, 6, 8 and 10mm, are used. There are many more varieties of mini-implants, but the author uses the simplest types.

6mm - maxillary buccal interradicular area, midpalatal area

8~10mm - maxillary palatal interradicular area or areas with thick mucosa

Diameter (Figure 1-1-3)

Many companies make products ranging from 1.2 to 2.0mm. The author uses only 1.6mm diameter products. The 1.2~1.4mm diameter is too weak to be used with the non-drilling method, and the 2.0mm is too thick to be used interradicularly.

Size (Diameter x Length, mm)	Indication	Code*
1.6 × 6	• Labial and buccal inter-radicular space, where the mucosa is thin • Mid-palatal area	16-JA-006H (Figure 1-1-3)
1.6 × 8	• Most palatal interradicular space	16-JA-008H
1.6 × 10	• Palatal interradicular space, esp. where the mucosa is very thick	16-JA-010H

* Jeil Medical Corporation, Dual Top™ Anchor System, Seoul, Korea

Figure 1-1-1. Shape of the drilling screw tip

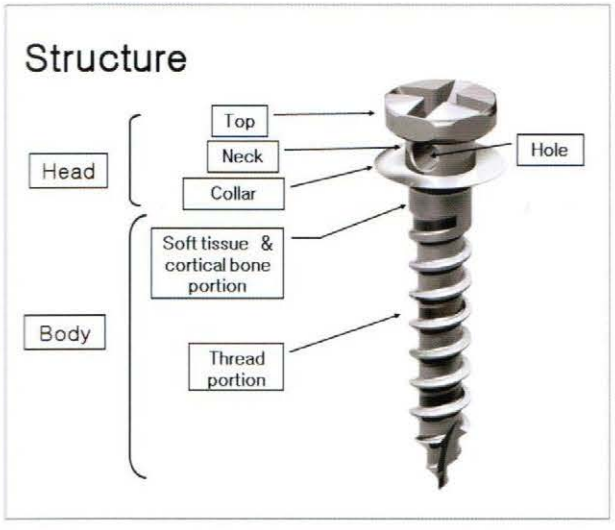


Figure 1-1-2. Mini-implant structure and name
Jeil Medical Corporation, Dual TopTM Anchor System, Seoul, Korea.
• Model name : 16-JA-008H (1.6×8mm)

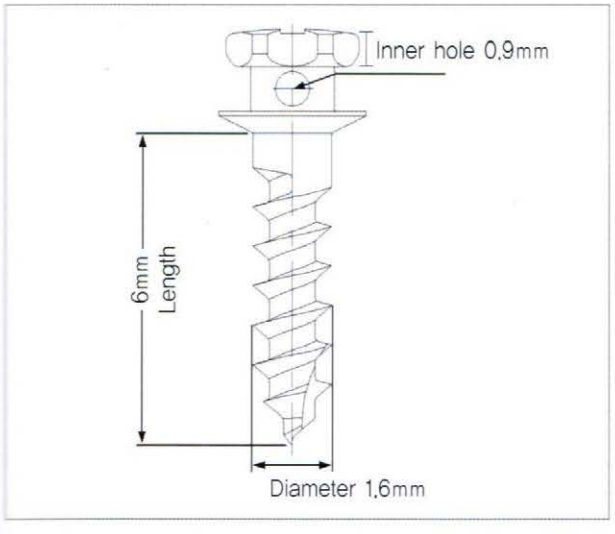


Figure 1-1-3. Size of the mini-implant
• Model name : 16-JA-006H (1.6×6mm)
• Diameter available in 1.4mm, 1.6mm and 2.0mm
• Length available in 6mm, 8mm and 10mm
• Diameter of the inner hole is 0.9mm

Head selection according to shape

In the early days, the author borrowed bone screws from the oral surgery department. However, when elastics were hooked onto the screws, it pressed down on the gingiva and caused side effects such as inflammation, hyperplasia and ulceration. The Dual Top Anchor System eliminates such side effects and has become the preferred option. Other products have also been developed to satisfy the tastes of various clinicians. Each company has many different models to satisfy the demands of clinicians. But the cases contained in this book will show that the product and model used by the author are very simple. The aim of this book is not to introduce all of the products and techniques available in the market, so only a few varieties will be presented.

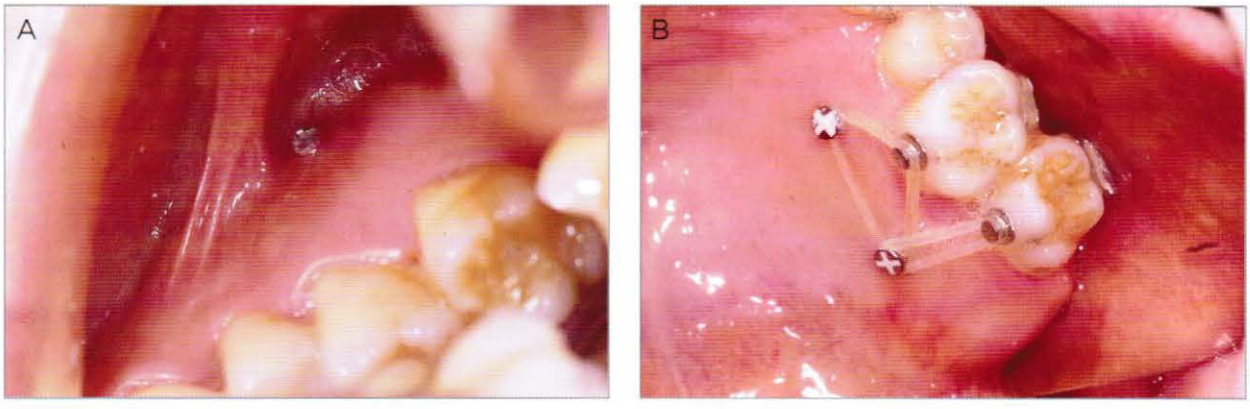


Figure 1-1-4. Early bone screws used for maxillofacial surgery
A. Because the head shape has a typical screw form, it caused gingival impingement when elastics were applied. If the screw was inserted in the movable mucosa rather than the attached gingiva, there was especially more inflammation and higher rates of failure.
B. Without a neck and collar in the head of the screw, the elastics are pushed down into the soft tissues. Because mini-implants are now being made with a neck and collar, these discomforts have been eliminated.

1) Type JA (Figure 1-1-5A, Figure 1-1-6)

This is the type that the author enjoys using. The structure is the same as that given in Figure 1-1-2. The hexagonal shape of the top part is manufactured to fit the matching hand driver. The cross-shaped groove on the top of the head will allow an ordinary cross-head screw driver to be used. The neck is used to hook elastics or Ni-Ti coil spring. The collar region covers the soft tissues and prevents external irritants from entering. The hole in the neck region (diameter 0.9mm) can be used in a variety of ways as wire can be threaded through. The screw body has been designed to be compatible for both the soft tissue and cortical bone. Recently microgrooves have been added to this area for better adaption with the soft tissues and to inhibit penetration from various oral bacteria. Products with double threading have also been developed to increase stability in cortical bone. Occasionally brackets are bonded with resin in the top of the mini-implant. Because the top area is large and has a cross-shaped groove, it is favorable for bonding. The body has a cylindrical

shape. Recent studies comparing the stability of cone and cylinder shaped mini-implants indicate that the cone shape does not have a distinct advantage over the cylinder shape.

2. Type JB (Figure 1-1-5B, Figure 1-1-7)

This type is used by many clinicians with the hope that the small head area will give less discomfort for patients. Using NiTi coil spring with the specially designed ring (Figure 1-1-7) means that there is no need to ligate the spring each time which lessens patient discomfort. The JB type is most preferred in such treatment as mouth protrusion.

3. Type JD (Figure 1-1-5C, Figure 1-1-8)

Occasionally brackets are bonded onto the head part of the mini-implant. However, to improve the complicated bonding procedure, this mini-implant has been designed with a bracket slot and wing in the head part. The slot size is 0.022 inch in width and 0.029 inch in depth.

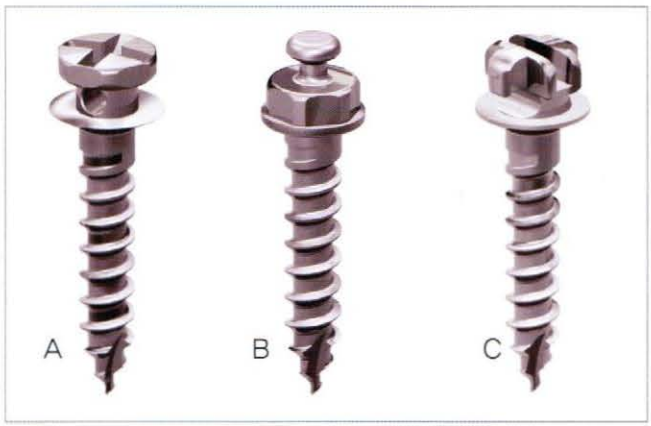


Figure 1-1-5. Type of head design used most often
A. Type JA. The design readily used by the author. The hole in the neck region is 0.9mm in diameter.
B. Type JB. Popular design used by many clinicians with the hope of lessening discomfort for patients.
C. Type JD. The mini-implant head includes a bracket slot and wing. Slot size is 0.022 inch in width and 0.029 inch in depth.

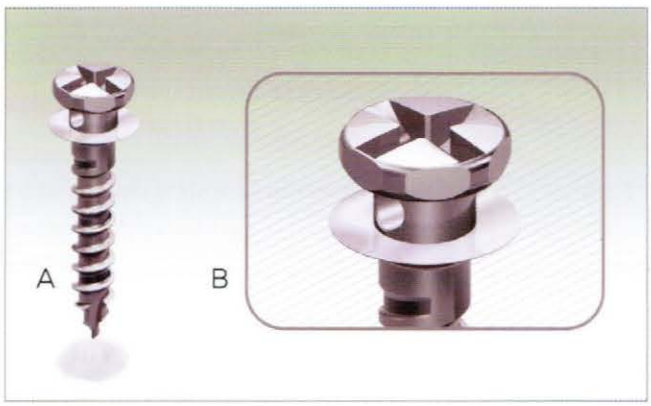


Figure 1-1-6. Head shape of type JA
The hole in the neck region is 0.9mm in diameter.

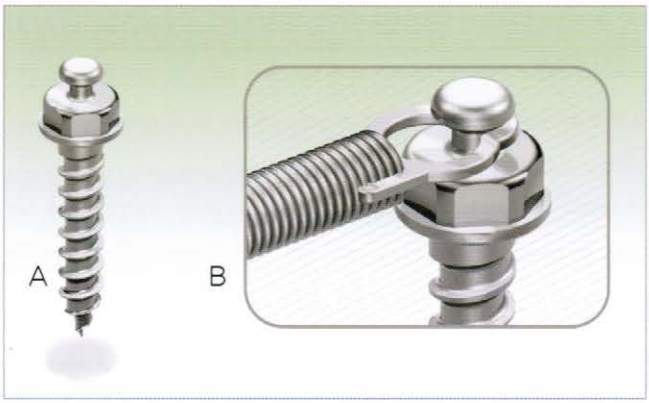


Figure 1-1-7. Type JB and NiTi closed coil spring
Previously NiTi closed coil spring was ligated onto the mini-implant with ligature wire. With the development of coil spring with an open loop, it is easily hooked onto the head of the mini-implant and secured by pulling onto the small loop.

Figure 1-1-8. Type JD
The mini-implant head includes a bracket slot and wing. Slot size is 0.022 inch in width and 0.029 inch in depth. A rectangular wire has been ligated.

Ⅱ. Instruments

Screw Block (Figure 1-1-9)

Hand driver, driver shaft, and mini-implants can be stored. The whole block can be sterilized.

Hand driver and driver shaft (Figure 1-1-10)

The hand driver and driver shaft must be purchased to fit the design of the mini-implant. The models presented here are suitable for the JA type which the author uses. The product catalogue must always be consulted as even different models of the same company may need different driver shafts.

Two different driver shafts (Figure 1-1-10B, C) may be selected for the screw driver body (screw driver body, 110-010, Figure 1-1-10A). The driver shaft mostly used is the wrench-type made to fit the hexagonal screw head (hexa driver shaft, 113-MD-103, Figure 1-1-10A, B, D). With use, the edges of the hexagonal head can be worn down or the surrounding soft tissues may cover the neck of the head through hyperplasia. In these situations, the cross driver shaft (cross driver shaft, 113-MD-101, Figure 1-1-10C) which fits onto the cross head groove on top of the head may be used.

Endodontic contra-angle handpiece (Figure 1-1-11)

An endodontic contra-angle handpiece can be used at a speed of less than 30rpm for mini-implant insertion. With the contra-angle handpiece, there is no need to buy either the short finger driver (Finger driver, 111-120), or the lingual driver (Lingual driver, 111-LD-010).

Short hand driver (Figure 1-1-12)

The short hand driver is required when inserting mini-implants into the midpalatal region. The driver must be small enough to be inserted into the mouth to gain access to the midpalatal area. The long length of a standard hand driver causes it to contact the lower incisors and prevent proper access to the midpalatal area. A bur-type wrench (113-MJ-203) is connected to the short hand driver. Because the midpalatal cortical bone is very dense, pilot drilling is recommended.

Lingual hand driver (Figure 1-1-13)

This hand driver shaped like a contra-angle handpiece (Lingual driver, 111-LD-010) can be used in narrow areas such as posterior interradicular (buccal or palatal) areas where long hand driver access is difficult. It can be used in the midpalatal area also. Pilot drilling is recommended for insertion into the midpalatal area and mandibular dense cortical bone.

Dental implant engine and handpiece (Figure 1-1-14)

At the Department of Orthodontics, SNUDH, an engine and handpiece designed for dental implant insertion is being used. Although the high cost is a disadvantage, orthodontic clinics will need this device with the increasing number of mini-implant use nowadays. Speed control is convenient, and a sterile cooling device is available. Normally speed is set at 30 rpm with a force of 50 Ncm. Saline can be dripped onto the tip of the handpiece for cooling.

Bur-type wrench (Figure 1-1-15)

Long type (Figure 1-1-15A, 113-MD-204)

This is used for insertion into the midpalatal area. It is used mainly with the endodontic contra-angle handpiece or the dental implant engine handpiece.

Short type

This is used when inserting into narrow areas such as posterior buccal areas or palatal interradicular areas. It can be inserted also into the short hand driver (Finger driver, 111-120) for use in the midpalatal area.

Bur-type crosshead driver (Figure 1-1-10C, 113-MD-201)

Although the frequency of use is low, it can be used in cases where the hexagonal head is damaged, or when the neck is buried in soft tissue.

Pilot drill (112-MC-201)

For insertion into the midpalatal area or the mandibular buccal bone, the cortical bone may be too thick to insert mini-implants with the non-drilling method. In these cases, pilot drilling in the cortical bone will make insertion much easier. Cooling irrigation is required during pilot drilling.

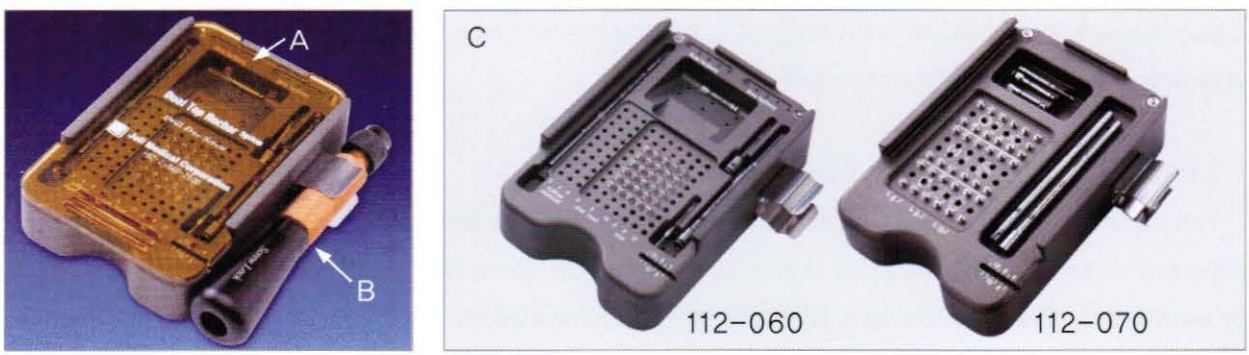


Figure 1-1-9. Required instruments
A, B. Screw block and instrument set. This can be sterilized as a whole.
C. 112-060 and 112-070 screw blocks are also available.

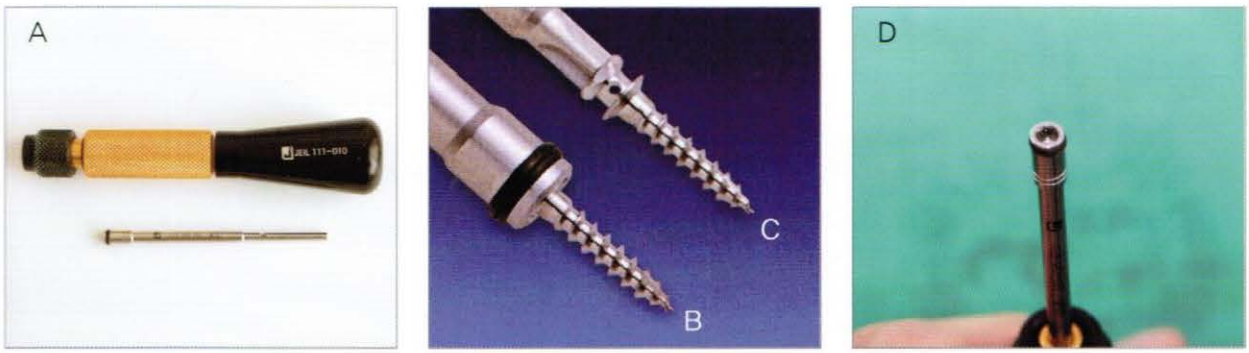


Figure 1-1-10. Hand driver and driver shaft
A. Screw driver body (111-010) and hexagonal wrench-type driver shaft (hexa driver shaft, 113-MD-103)
B. Hexagonal wrench-type driver shaft (hexa driver shaft, 113-MD-103) with mini-implant in place
C. Cross driver shaft (cross driver shaft, 113-MD-101) with mini-implant in place
D. Inner view of hexagonal wrench-type driver

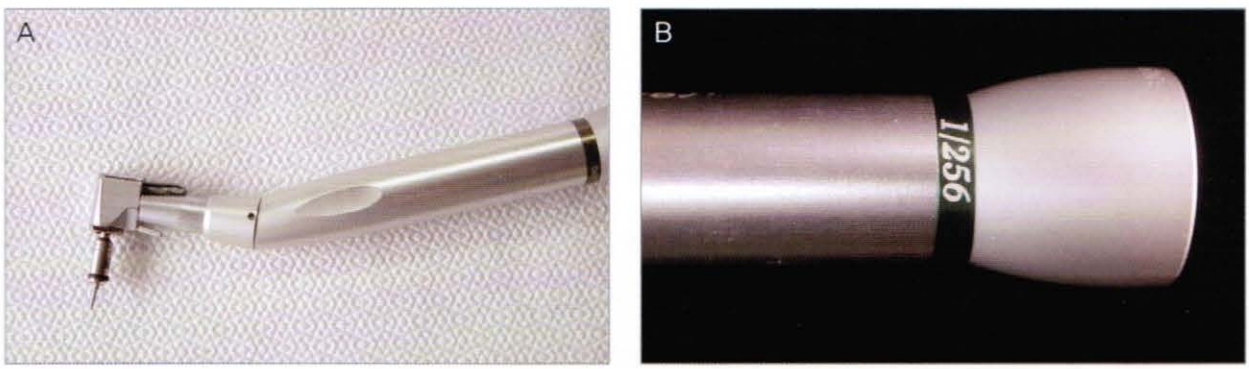


Figure 1-1-11. Endodontic contra-angle handpiece
A. For use in the midpalatal area, a long bur-type hexagonal wrench (113-MD-203) and endodontic contra-angle handpiece is assembled. Reducer contra-angle, Anthogyr company (Sallanches, France)
B. The speed is reduced to 1/256, and the torque inversely increased.

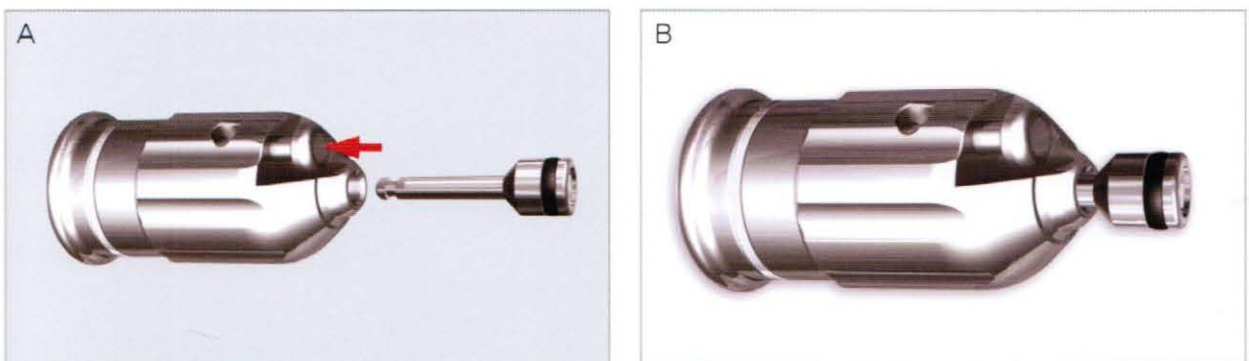


Figure 1-1-12. Short hand driver
This specially designed short hand driver (Finger driver, 111-120) is used for insertion into the midpalatal area. With a length of 28mm, it can be inserted into the mouth. A short bur-type wrench (113-MJ-203) is connected for use in the midpalatal area.
A. Pressing the button (arrow) will allow the short bur-type wrench (113-MJ-203) to be inserted. The button is then released.
B. Assembled device. Floss can be threaded through the hole in the middle of the driver and extended out of the mouth to prevent accidental swallowing.

Figure 1-1-13. Angle-type hand driver
A short bur-type wrench(113-MJ-203) is used in an angle-type hand driver(Lingual driver, 111-LD-010). It is used in the posterior buccal interradicular area, with pilot drilling due to the thick mandibular cortical bone.

Figure 1-1-14. Dental implant engine and handpiece
It is set to 30rpm and 50Ncm.
(Manufacturer: W&H (UK) Limited, 6 Stroud Wood Business Centre, Park Street, St Albans, Hertfordshire, AL2 2NJ, UK. Provider : SHINWON DENTAL CO., LTD. #697-43, Yeoksam-dong, Kangnam-Gu)

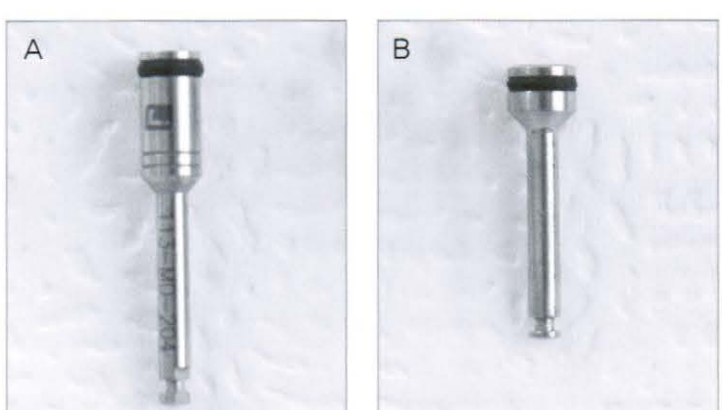


Figure 1-1-15. Bur-type wrench
A. Long type (113-MD-204) : used for the midpalatal area. Used with the endodontic contra-angle handpiece, dental implant engine handpiece, or lingual hand driver.
B. Short type (113-MJ-203) : used in narrow areas such as posterior buccal or interradicular areas with the endodontic contra-angle handpiece, dental implant engine handpiece or lingual hand driver. Together with the short finger driver (111-120), it is used in the midpalatal area.

Clinical tip ››››

What kind of instruments will I need for my first mini-implant procedure?

Because many products and models are available, many clinicians can feel overwhelmed when first deciding which models to purchase. With many questions regarding the essential items, a summary is given below.

Screw Block	112-070	Used to arrange and sterilize instruments
Mini-implant		
1.6 × 6.0	16-JA-006H	Used most often (80%)
1.6 × 8.0	16-JA-008H	Used occasionally (15%)
1.6 × 10.0	16-JA-010H	Used rarely but essential in some situations (5%) (use % as a guide for purchasing each type)
Screw driver body	111-010	
Hexagonal driver shaft	113-MD-103	
Reducer contra-angle		Purchase an endodontic contra-angle handpiece
Bur-type driver shaft		
Short type	113-MJ-203	
Long type	113-MD-204	
Pilot drill	112-MC-201	Used when inserting into the midpalatal area or mandibular buccal interradicular area, when the thick cortical bone makes the non-drilling method difficult

* : Jeil Medical Corporation, Dual Top™ Anchor System, Seoul, Korea

Ⅲ. Instrument use

Connecting the screw driver body and shaft (Figure 1-1-16)

To connect the driver shaft (hexa driver shaft, 113-MD-103) to the screw driver body (110-010), hold the black rugged portion of the screw driver body down, insert the driver shaft, and release the rugged portion.

When using the endodontic handpiece or dental implant engine handpiece, use in the same manner as fitting a normal bur.

How to pick up a mini-implant (Figure 1-1-17)

From the row of mini-implants (Figure 1-1-17B) arranged in the screw block (Figure 1-1-17A), fit the hexagonal wrench portion of the driver shaft (Figure 1-1-17C) onto the head of the mini-implant and lift up (Figure 1-1-17D). The mini-implant will be held in place due to friction between the head and wrench (Figure 1-1-17E). The mini-implant well fitted onto the shaft will not be removed even when transferring into the patient's mouth. Positioning the mini-implant in the correct position is also made easier as a consistent angle is maintained between the mini-implant and hand driver.

For use with endodontic handpiece or dental implant engine handpiece, the bur-type wrench can be easily fitted onto the mini-implant head.

Figure 1-1-16. Connecting the screw driver body and driver shaft
To connect the screw driver body (110-010) and driver shaft (hexa driver shaft, 113-MD-103), the black rugged portion is held down with the thumb and forefinger (A), the driver shaft is inserted (B), and the rugged portion is released (C).

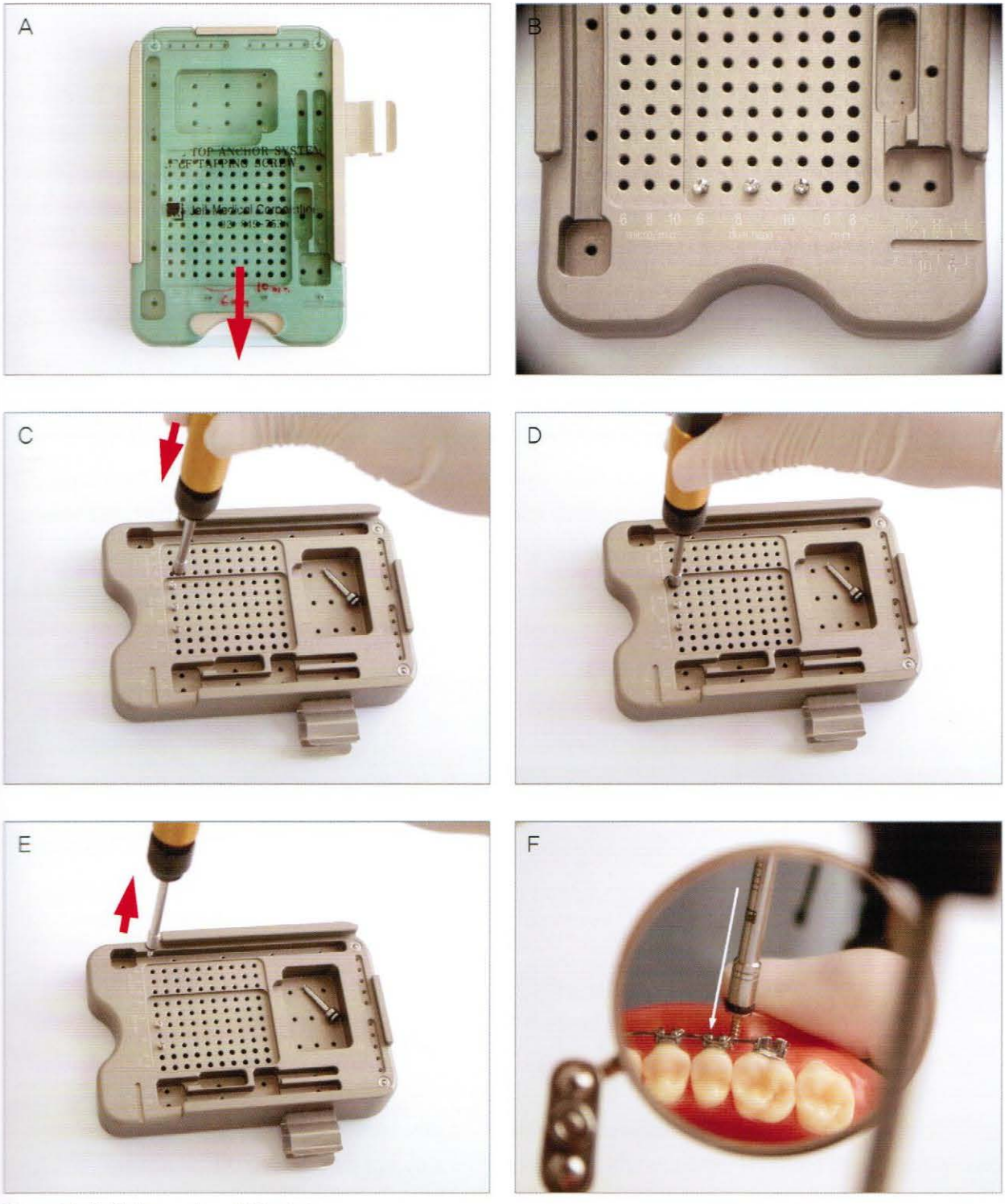


Figure 1-1-17. Picking up the mini-implant

A. Screw Block. The lid is opened by sliding in the direction of the arrow.

B. The mini-implants are arranged according to their length, diameter and type in the screw block.

C. The hexagonal wrench portion of the driver shaft is fitted vertically onto the mini-implant head.

D. The mini-implant is lifted up vertically.

E. The mini-implant is held in place in the driver shaft wrench due to friction.

F. The mini-implant is transferred into the patient's mouth. As the mini-implant and hand driver are held at a consistent angle, it makes it easier to position the mini-implant inside the patient's mouth. The driver shaft axis can be used as a guide for judging the mini-implant insertion angle.

Ⅳ. Preparing for insertion.

Disinfection and supply of mini-implant and instruments

Disinfection refers to the removal of most pathological microorganisms with the exception of bacterial spores. Sterilization refers to the physical and chemical removal and destruction of all microorganisms including spores. According to the classification by E.H. Spalding, surgical instruments and mini-implants are classified as highly dangerous and require sterilization prior to use.

What is the disinfection method used in hospitals, and what are the methods recommended for smaller clinics?

These days delicate and elaborate surgical instruments, as well as plastic and rubber materials are used which is heat intolerable and sensitive to moisture. These situations warrant the use of EO (ethylene oxide) gas in large hospitals. A canister is used, or EO gas is inserted into envelopes containing instruments. The time for EO gas sterilization is dependent on the concentration of EO gas, but in general complete sterilization requires 3-7 hours when the concentration of EO gas in the chamber is 450-1,000mg/liter.

At our department, the screw block is wrapped in surgical cloth for sterilization and storage. Individual mini-implants and instruments are placed in sterilization bags for EO gas sterilization (1 hour at 55° or 3 hours at 37°, Figure 1-1-18).

Figure 1-1-18. Mini-implant and instruments wrapped individually for EO gas sterilization

The advantages of EO gas are that it destroys all microorganisms, and does not require high temperature, humidity or pressure. It does not cause damage to instruments. However, exposing materials or instruments to EO gas for long periods mean that even longer periods of exposure into air are needed. High cost compared to steam autoclaving is another disadvantage. If liquid EO contacts skin, it can cause sever burning and its carcinogenic properties call for care during handling. Therefore use of EO gas in private clinics is difficult.

Instead, autoclave is recommended for mini-implant sterilization. If wrapped in surgical cloth, 29.4 psi at 134°C for 10 minutes is recommended. A screw block (with all the required instruments arranged inside) can be used, or each instrument wrapped separately. This is known as the most cost effective method, but is impossible to be used on instruments which cannot resist heat.

Preparation for insertion

1. Hand washing prior to surgery

Hand and forearm are washed with antibacterial solution.

Antibacterial handwash used in the Department of Orthodontics, SNUDH

Types	Contents	Method	Method
Microshield	4% chlorhexidine gluconate	Rub for 10–15 seconds	Use 5ml water
Avegard	0.5% chlorhexidine gluconate +70% ethyl alcohol	Rub for 10–15 seconds and dry	Use without water

2. Gloves

Sterilized gloves are worn.

3. Patient disinfection

1) Skin disinfection

Hibitane (0.5% chlorhexidine) is used to disinfect the area around the mouth and lips.

2) Surgical drape

Non-disinfected areas are covered with surgical drape, and only the clean areas are exposed. Drape with a hole in the middle is used to expose only the area around the mouth.

3) Disinfection in the oral cavity

Even when surgery is limited to a small area of the mouth, the entire oral cavity should be disinfected. Betadine (Besetin liquid, 100ml with 10g concentration of povidone iodine, Hyundai chemicals) is used around the teeth and mucosa.

References

1. APIC Guideline for selection and use of Disinfectants (1996)
2. Seoul National University Infection Control guidebook
3. Crawford JJ: Clinical asepsis in dentistry: regulation, infection control, Chapel Hill, NC,1992, CIC Publishing Co
4. Theodore M. Roberson: Sturdevant's Art and Science of Operative Dentistry: Infection control, Chapel Hill, NC, 2001, Mosby

Chapter 2

Mini-implant insertion technique

Chapter 2 Mini-implant insertion technique

I . Anatomic considerations

Popular location for insertion (decreasing order)

1) Interradicular space between upper second premolar and first molar (buccal)
2) Interradicular space between upper second premolar and first molar (palatal)
3) Midpalatal suture area
4) Interradicular space between upper lateral incisor and canine (labial)
5) Interradicular space between upper first molar and second molar (palatal)
6) Interradicular space between central incisors
7) Interradicular space between lower second premolar and first molar (buccal)
8) Interradicular space between lower lateral incisor and canine (labial)
9) Edentulous alveolar ridge
10) Maxillary tuberosity
11) Other areas without anatomic limitations

Areas without anatomic limitations such as root, vessels, nerve, maxillary sinus and nasal cavity can be implanted. After examination of each case, mini-implant is inserted and creative mechanics applied.

- Interradicular space between lower first premolar and second premolar (labial)

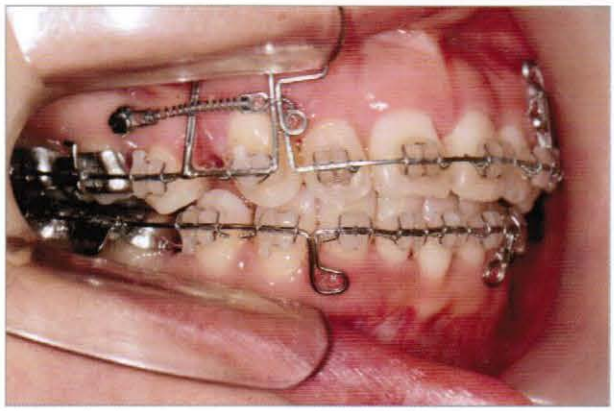


Figure 2-1-1. Interradicular space between upper second premolar and first molar (buccal)
This site is used most often. A 1.6×6mm mini-implant is used. En masse retraction of upper incisors in a mouth protrusion case is shown.

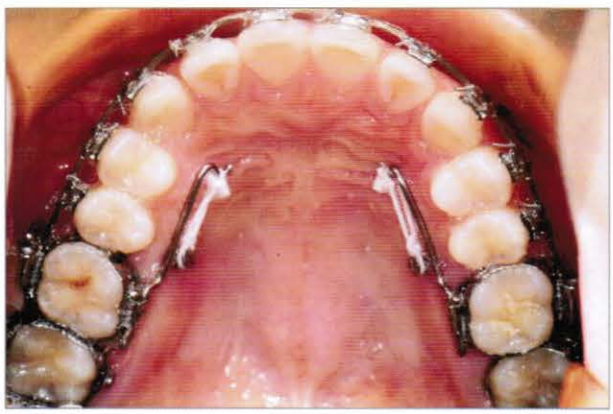


Figure 2-1-2. Interradicular space between upper second premolar and first molar (palatal)
While the buccal interradicular space may be narrow, the palatal side is usually wider. This is due to the single palatal root of the upper first molar. A 1.6×8mm length mini-implant is required as the mucosa in this area is thicker. This case presents distalization of molars using SPA.

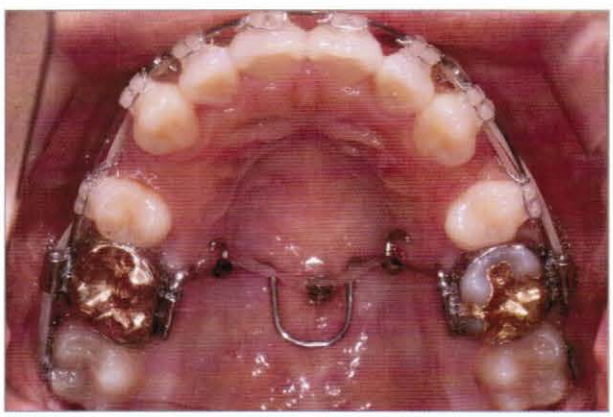


Figure 2-1-3. Midpalatal suture
A 1.6×6mm mini-implant has been inserted for intrusion of upper molars in an anterior open bite case. Antero-posteriorly the mini-implant should be positioned along a line connecting the first molars.

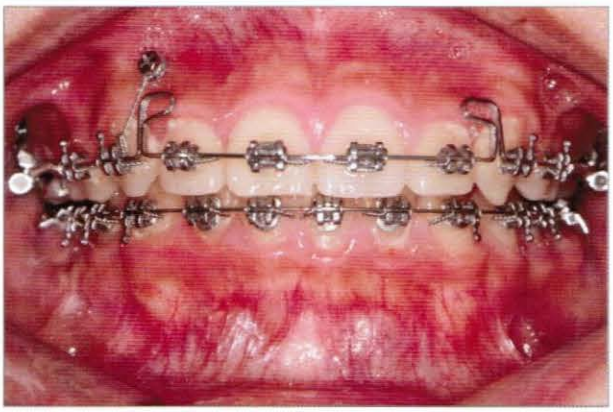


Figure 2-1-4. Interradicular space between upper lateral incisor and canine (labial)
Use a 1.6×6mm mini-implant.

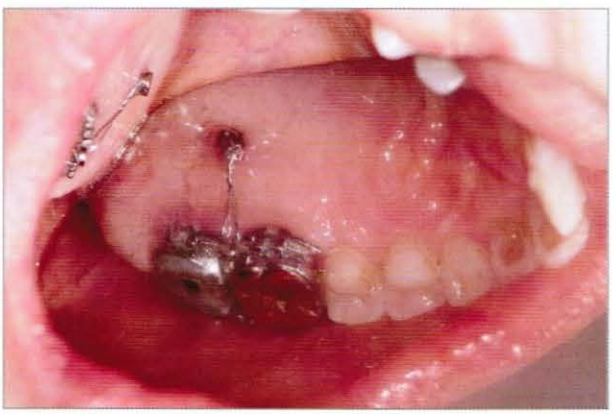
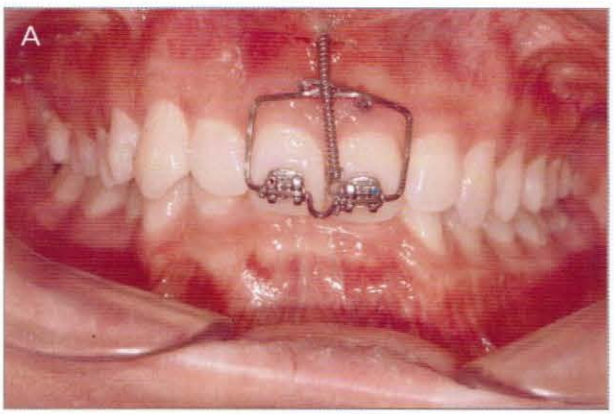


Figure 2-1-5. Interradicular space between upper first molar and second molar (palatal)
A 1.6×6mm mini-implant has been inserted for intrusion of extruded first and second molar. In this photograph, a ligature wire is holding the molars in position at the completion of intrusion.



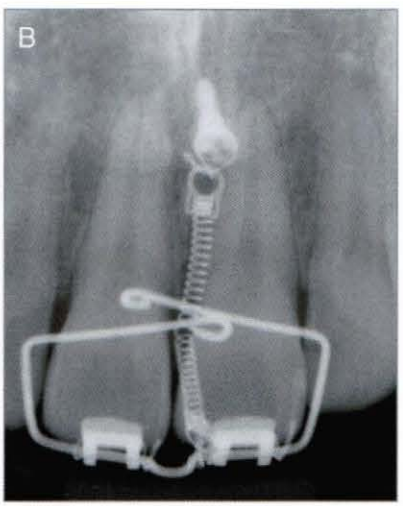


Figure 2-1-6. Interradicular space between the central incisors
A 1.6×6mm mini-implant is inserted. Overerupted central incisors are being intruded.

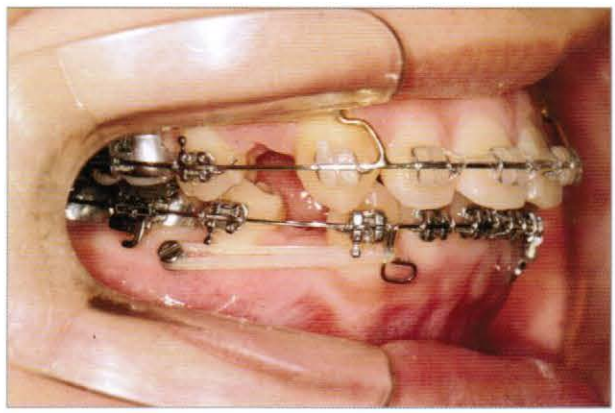


Figure 2-1-7. Interradicular space between lower second premolar and first molar (buccal)
A 1.6×6mm mini-implant is used. Good indications are hard to find as the attached gingival is narrow compared to the maxilla. Fortunately the mandibular molars themselves provide good anchorage, so indications for reinforced anchorage through mini-implants are rare.

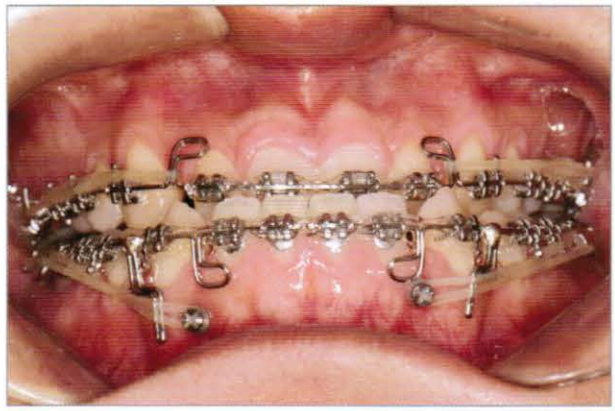
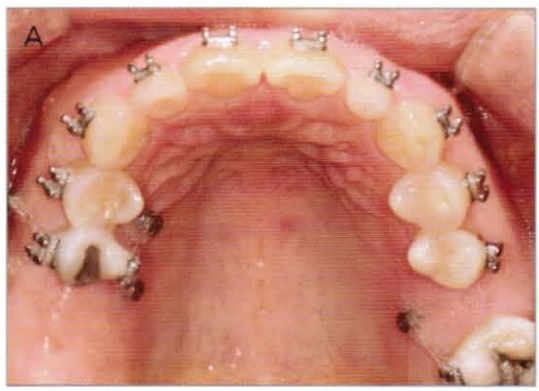


Figure 2-1-8. Interradicular space between lower lateral incisor and canine (labial)
A 1.6×6mm mini-implant is being used for forward protraction of lower molars.



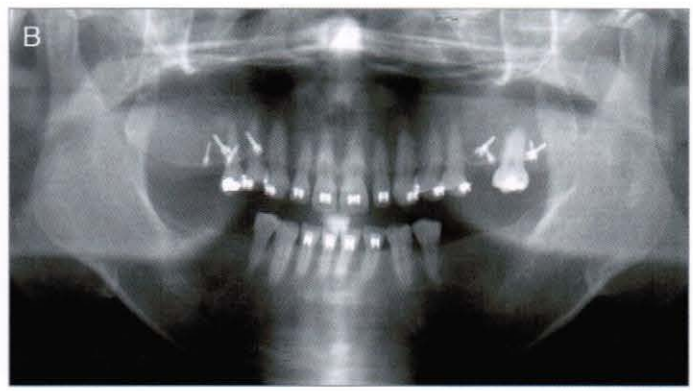


Figure 2-1-9. Edentulous alveolar ridge
Use 1.6×8mm or 10mm mini-implants in edentulous ridges. An extruded upper right second premolar and left second molar are being intruded.

Figure 2-1-10. Maxillary tuberosity
A 1.6×8mm or 10mm mini-implant is being used. Overerupted upper first and second molars have been intruded, and is retained with ligature wire.

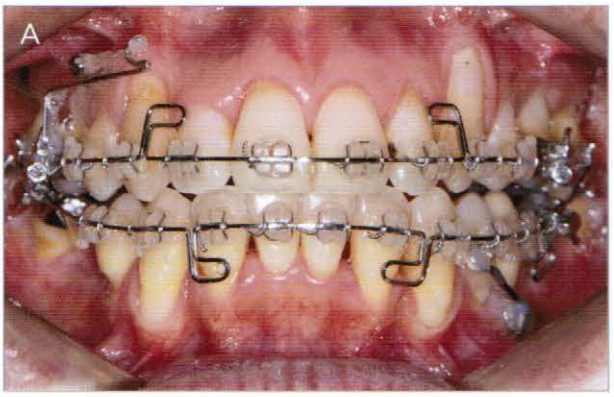


Figure 2-1-11. Interradicular space between lower first premolar and second premolar (labial)
After confirming the width of the interradicular space, mini-implants can be inserted in any location.
A. A 0.7mm wire is bonded between the lower left first premolar and head of the mini-implant.
B. The interradicular space between the lower left first and second premolars is wide.

Clinical considerations of each location

1. Upper interradicular area and extraction site

Let me explain with a patient treated for mouth protrusion (Figure 2-1-12~22). Because loss of anchorage can occur due to natural mesial inclination of molars, a mini-implant can be inserted prior to commencing treatment. Radiographs of the relevant areas are required to ascertain whether enough space exists. Even if a panoramic radiograph is available (Figure 2-1-15), it is recommended that a periapical radiograph be taken for a better view of the interradicular area (Figure 2-1-16). The crowns of posterior teeth are overlapped and make it difficult to estimate the space between roots on panoramic radiography (Figure 2-1-15). CT is another option but the increased exposure to radiation and high costs are a burden. Clinically, good periapical radiographs with no overlapping of teeth is the best option (Figure 2-1-16). However in most cases, such as in this patient, crowding itself causes the teeth to be overlapped on x-ray. And because brackets have not yet been bonded, Kim's stent cannot be used. Teeth should be leveled up to 016x022″ NiTi before inserting Kim's stent for an accurate evaluation of interradicular space on periapical x-ray.

The author uses 022″ slot MBT (3M Unitek, Monrovia, CA) prescription brackets. Excluding special circumstances, mini-implant is usually inserted after leveling up to 016x022″ NiTi (Figure 2-1-17A). A CT taken at this stage will be used for explanations. Figure 2-1-17A shows CT taken parallel to the occlusal plane (Figure 2-1-17B). Figure 2-1-17B shows general features of each area to be considered when examining radiographs.

1) Interradicular area between upper second premolar and first molar (buccal, Figure 2-1-17B, arrows A & B)

The interradicular area in this region is usually fairly wide in the buccal side. However in this patient the space in the right side (arrow A) is narrow. Insertion into such narrow areas is not recommended.

The space between the upper left second premolar and first molar (buccal, arrow B) is wide enough for safe placement. Figure 2-1-17D also shows that the interradicular area is wide enough. Because the roots of the posterior teeth are leaning slightly distally (Figure 2-1-17D), the mini-implant should be inserted a little distal to the contact point. A 1.6x6mm mini-implant is suitable.

2) Interradicular space between upper second premolar and first molar (palatal, Figure 2-1-17B, arrows C & D) and interradicular space between upper first and second molar (palatal, Figure 2-1-17B, arrows E & F)

The centrally placed single palatal root of the upper molars allows adequate space between roots. Mini-implants can be inserted with minimal risk of injuring the roots. Arrows C, D, E, and F of Figure 2-1-17B, show that the palatal mucosa is relatively thick. Use a periodontal probe to investigate the thickness of the mucosa before insertion. A 1.6x8mm or 10mm mini-implant can be used. Because of the narrow interradicular space in the buccal side, the patient presented here had mini-implants inserted in the palatal side for activation of TPA+SPA (Figure 2-1-21A). The radiograph shows good insertion between roots (Figure 2-1-22A, B).

3) Interradicular space between the upper lateral incisor and canine (labial, Figure 2-1-17B, arrows G & H)

After leveling with the Roth set-up or MBT brackets, the canine roots are usually tilted distally. Therefore the space between canine and first premolar (or second premolar in extraction cases) is too narrow for mini-implant insertion. On the other hand there is ample space between the lateral incisor and canine for safe implantation.

4) Upper first premolar extraction area (Figure 2-1-17B, arrows I & J)

Extraction spaces are wide enough for safe mini-implant insertion. However in some cases, such as in Figure 2-1-17B arrows I & J, the cortical bone can be thinned or softened and cause failure of mini-implants. Therefore a longer 1.6x8mm or 10mm is preferred.

2. Lower interradicular area and extraction site

The cortical bone of the mandible is thick compared to the maxilla which causes insertion torque to be increased. Contrary to the belief that this will create higher stability, the failure rate of the mandible in patients is fairly high. This is because the interradicular space and the attached gingiva are both narrow, and causes the mini-implant to contact the periodontal ligament or root surface. Or the mini-implant is inserted too close to the gingival crest. In these cases, the alveolar bone bends according to movement of the tooth during mastication, causing trauma to the mini-implant and ultimately failure. Careful case and location selection is important for success. Figure 2-1-18A shows CT images taken parallel to the occlusal plane (Figure 2-1-18B). Figure 2-1-18B shows general features to be considered when examining radiographs.

1) Interradicular space between lower second premolar and first molar (buccal, Figure 2–1–18B, arrows K & L)

The interradicular space on the right side is narrow but the left shows wider spacing. Considering that the roots are leaning slightly toward the distal (Figure 2-1-18C, D), the mini-implant should be inserted a little distal to the contact point. A 1.6x6mm mini-implant is suitable. This case shows successful implantation and good results (Figure 2-1-21B, C, D, E). Radiograph shows good insertion between roots (Figure 2-1-22C).

2) Interradicular space between lower lateral incisor and canine (labial, Figure 2–1–18B, arrows M & N)

Similar to the maxilla, the lower canine also shows distal tipping of the canine root after leveling with the Roth set-up or MBT brackets. Therefore the space between canine and first premolar (or second premolar in extraction cases) is too narrow for mini-implant insertion. On the other hand there is ample space between the lateral incisor and canine for safe implantation. A disadvantage of the mandible is that the width of the attached gingiva is narrow. Patients with high tension of the lower lip may complain of discomfort. A 1.6x6mm mini-implant is appropriate.

3) Lower first premolar extraction space (Figure 2–1–18B, arrows O & P)

Extraction spaces are wide enough for safe mini-implant insertion. However in some cases, such as in Figure 2-1-17B arrows O & P, the cortical bone can be thinned or softened and cause failure of mini-implants. Therefore a longer 1.6 x 8mm or 10mm is preferred.

Clinical tip ››››

What is the minimum interradicular space needed for safe mini-implant insertion?

When using a mini-implant of 1.6mm diameter, a 1mm space on both the mesial and distal sides are required. Therefore a minimum of 3.6mm of space should be available between roots.

3. Midpalatal area

The bone thickness of the midpalatal area (upper first molar palatal root area, Figure 2-1-19A) in this patient is fairly thick (Figure 2-1-19B, arrow). This thickness will allow safe placement of a 6mm mini-implant.

However research by Kang et al (Figure 2-1-23) will show that in normal situations, the thickness of bone will decrease dramatically with more than a 3mm deviation from the center. It is therefore recommended that implantation is localized to the midpalatal area.

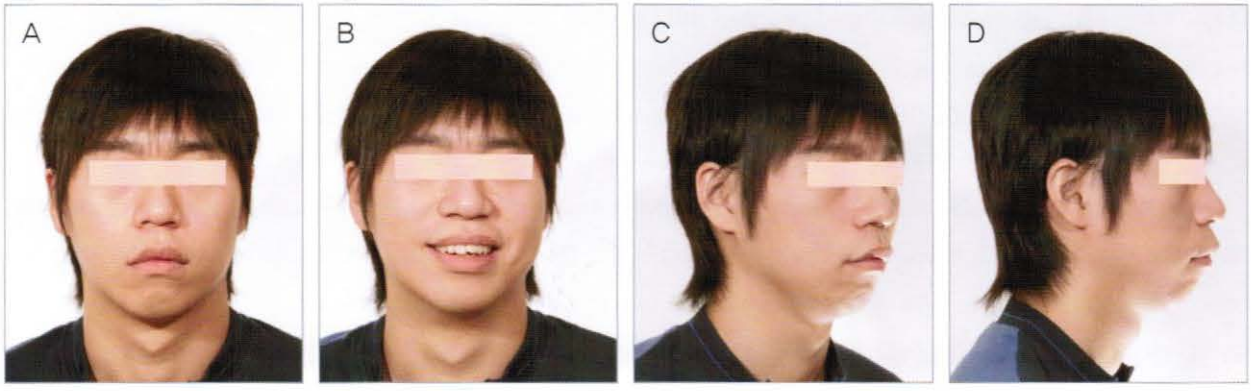


Figure 2-1-12. Extreme mouth protrusion case
Mini-implants were used on both the maxilla and mandible to reinforce anchorage.

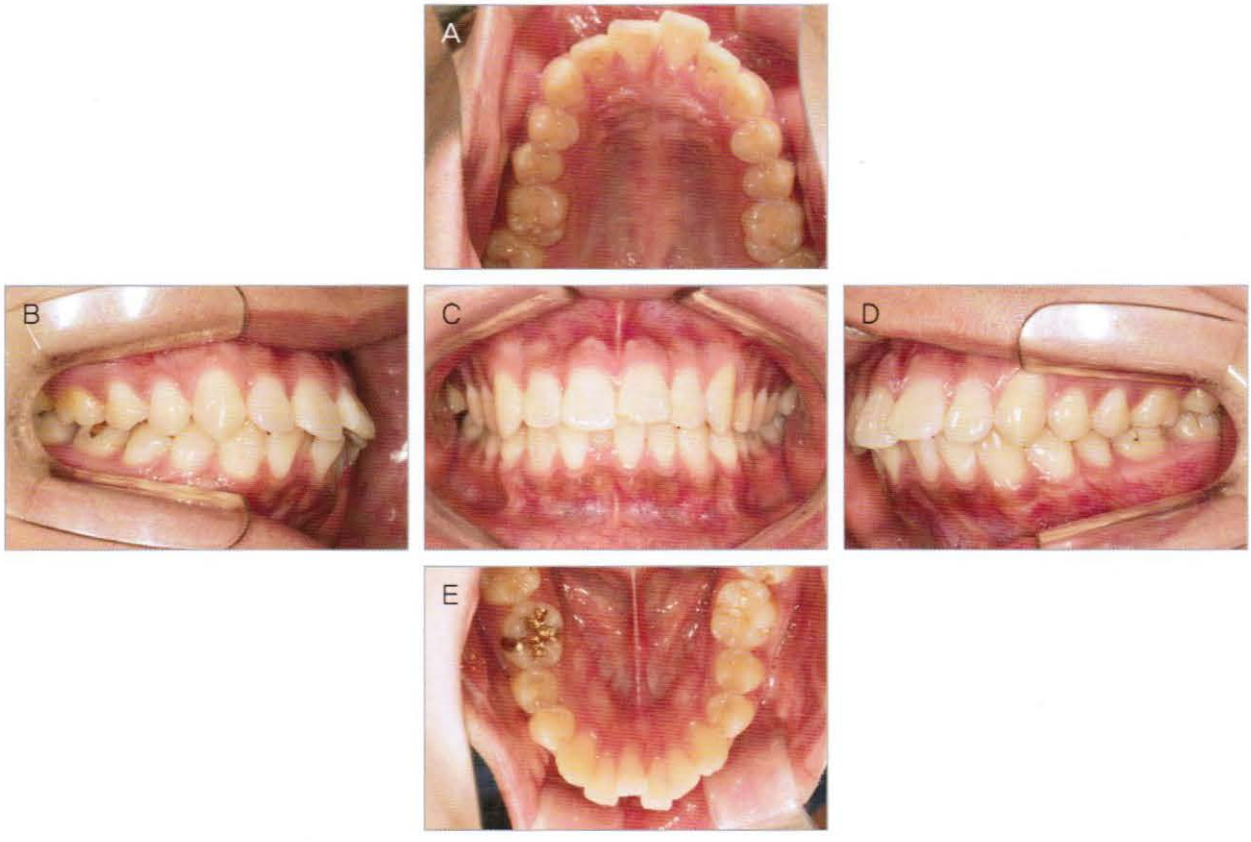


Figure 2-1-13. Pre-treatment intraoral photographs
Class I canine and molar key, and mild crowding is shown.

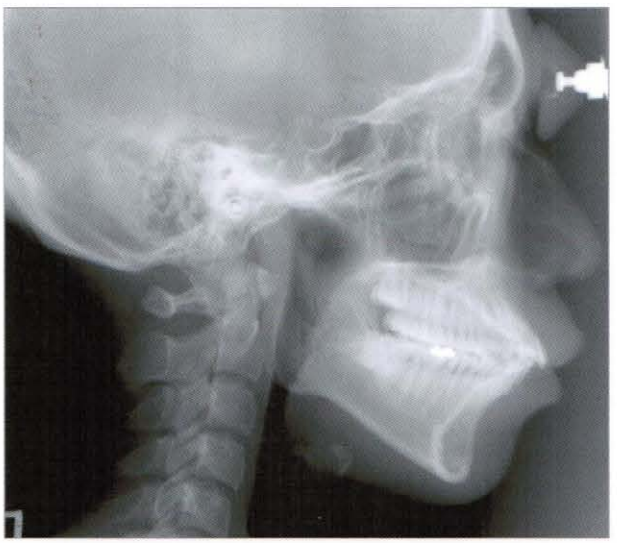


Figure 2-1-14. Pre-treatment lateral cephalometric radiograph

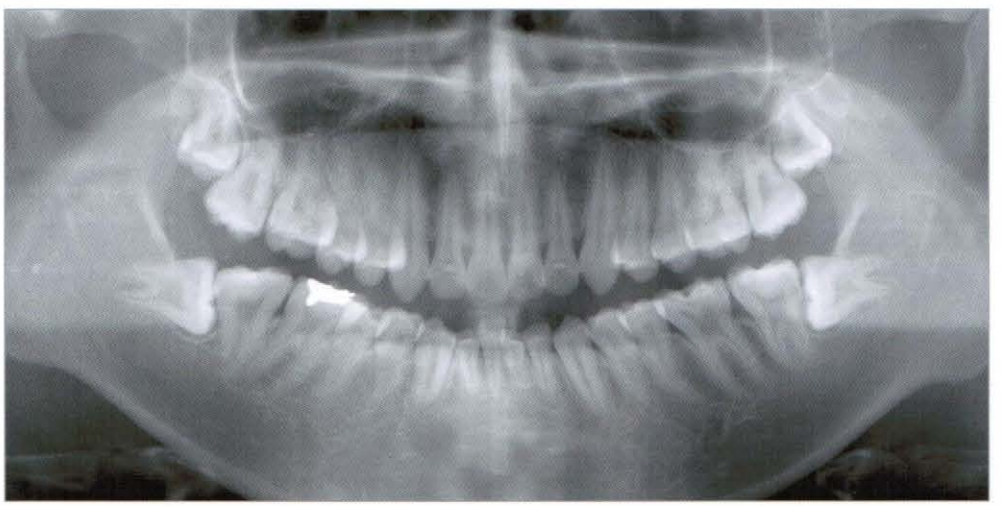


Figure 2-1-15. Pre-treatment panoramic radiograph
Interradicular spaces cannot be confirmed due to overlapping of roots. Crowding in the lower molar area has made the interradicular spaces very narrow.

Figure 2-1-16. Pre-treatment periapical radiographs of posterior teeth
More accurate interradicular space measurement is allowed.

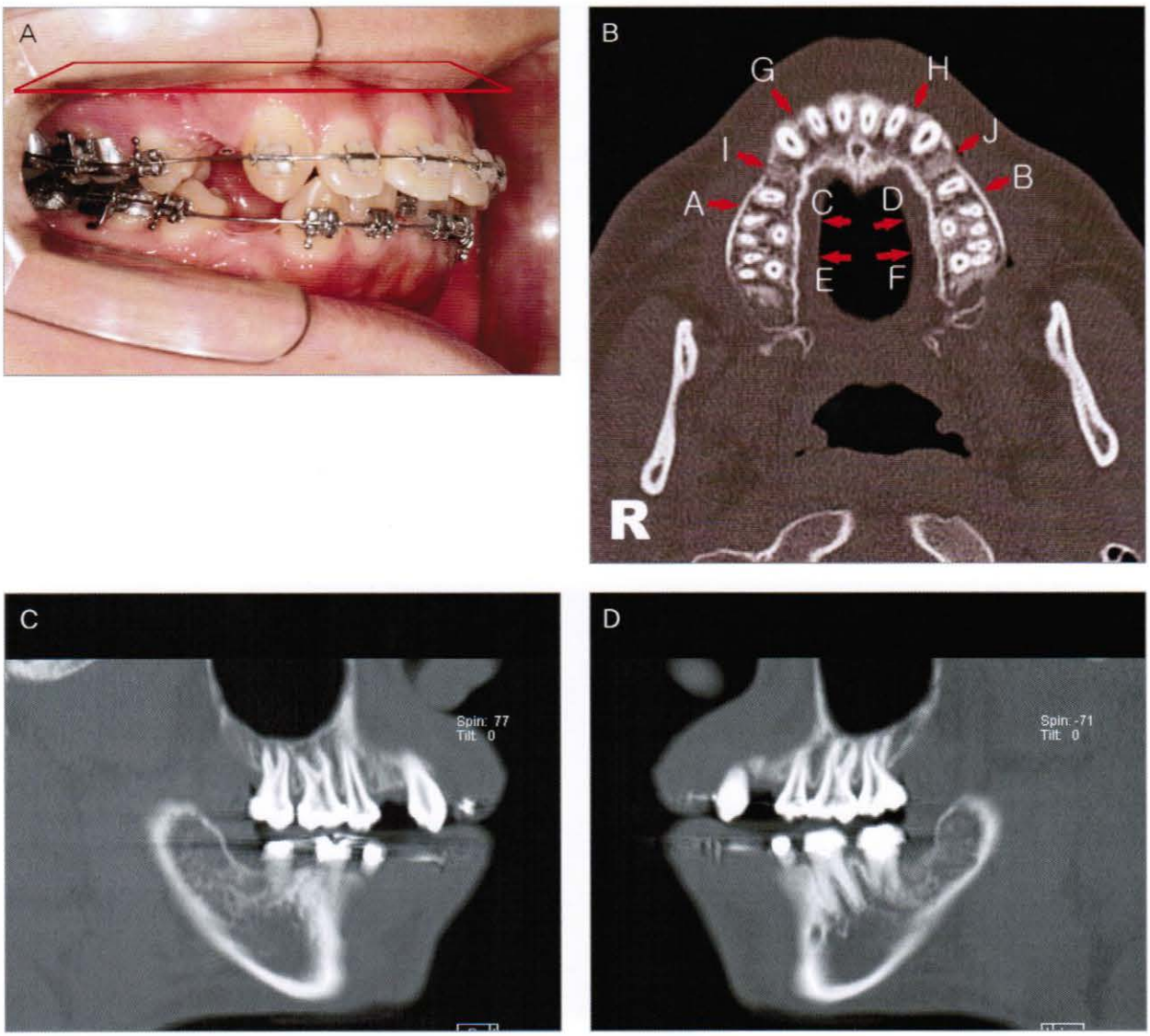


Figure 2-1-17. CT of maxilla
A. Taken parallel to the occlusal plane. Leveling up to 016×022" NiTi.
B. Left side of the image is the patient's right side. Arrows A to J show possible implantation sites.
C. The patient's right. Because the roots are leaning distally, this should be considered when deciding the position of insertion.
D. The patient's left. Interradicular space is wider than the right side. The roots are also leaning distally.

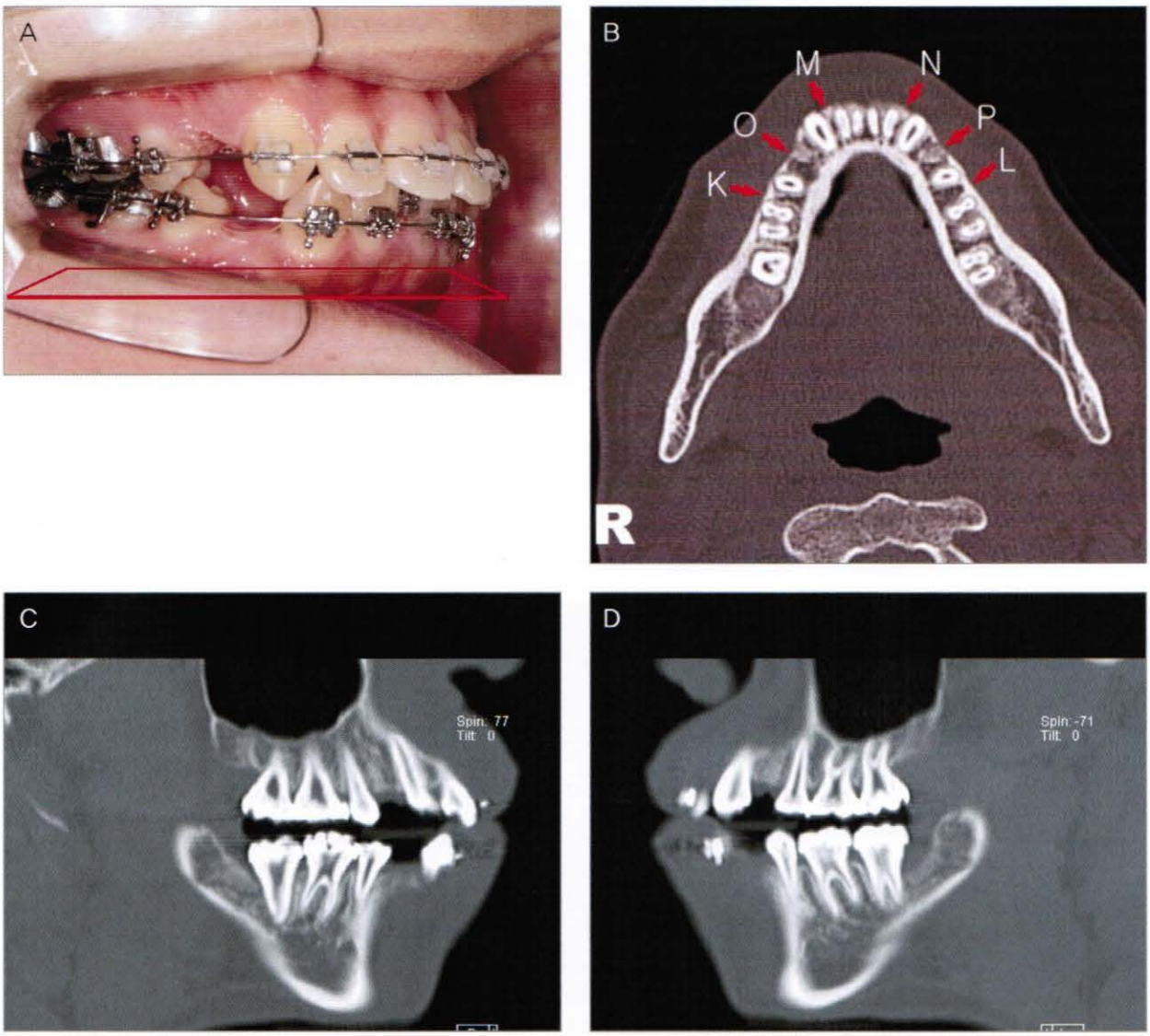


Figure 2-1-18. CT of mandible

A. Taken parallel to the occlusal plane.

B. Left side of the image is the patient's right side. Arrows K to P show possible implantation sites.

C. Patient's right. Because the roots are leaning distally, this should be considered when deciding the position of insertion. The interradicular area is narrower compared to the maxilla.

D. Patient's left. Interradicular area is narrower than the right. The roots are leaning distally.

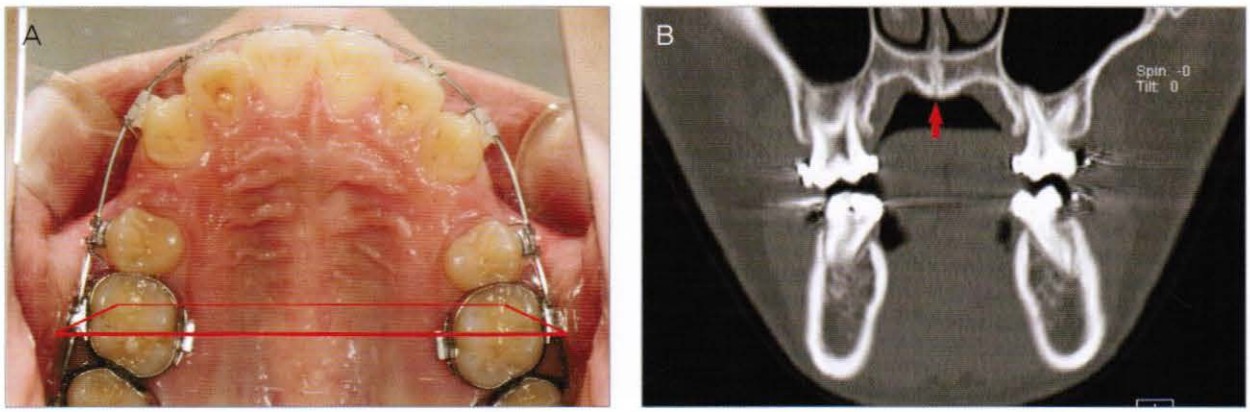


Figure 2-1-19. CT of upper first molar area
A. Taken perpendicular to the occlusal plane.
B. Bone thickness of the midpalatal area is fairly thick.

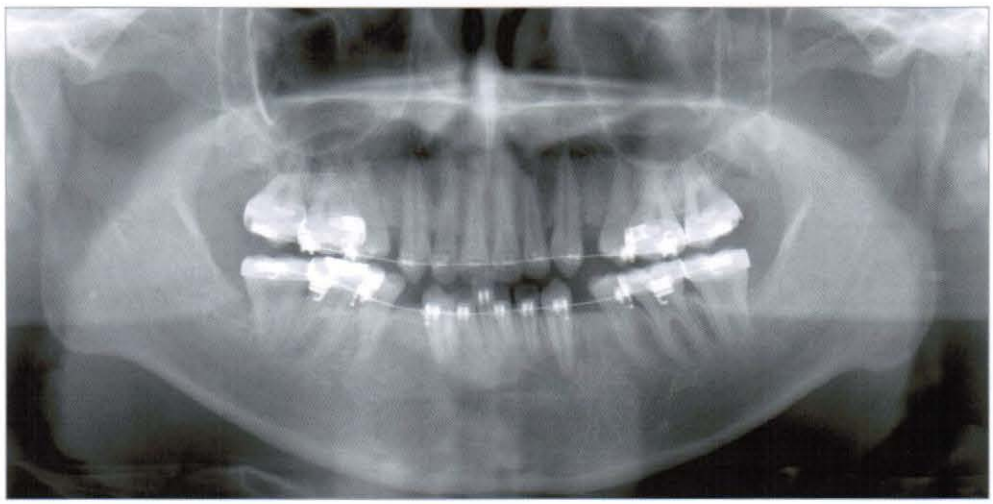


Figure 2-1-20. Panoramic radiograph after leveling (up to 016×022" NiTi)
Even after relief of crowding, it is difficult to ascertain the space between roots.

Clinical tip ››››

What kind of radiographs will I need?

1) For buccal or palatal interradicular spaces, periapical radiographs are taken. CT can be used for reference.

2) For measuring bone thickness in the midpalatal area, CT is taken (Figure 2-1-19).

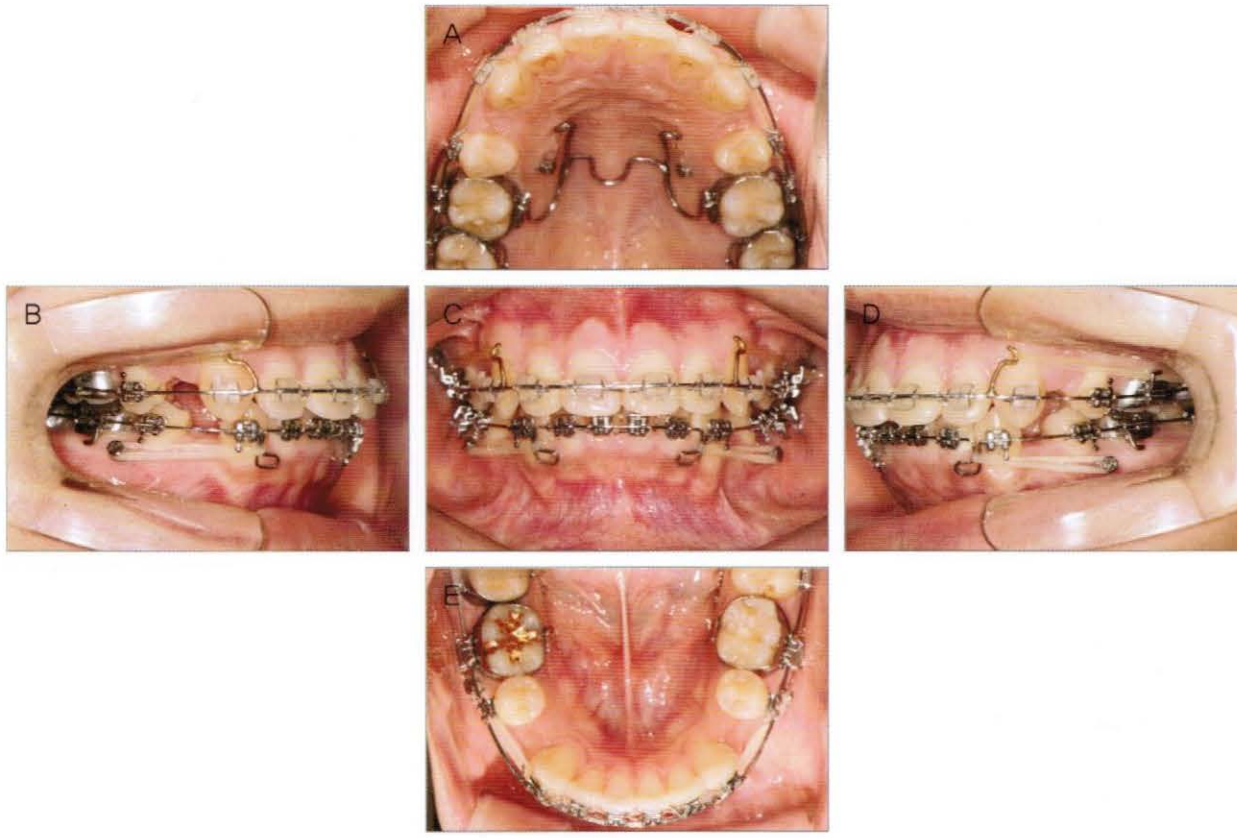
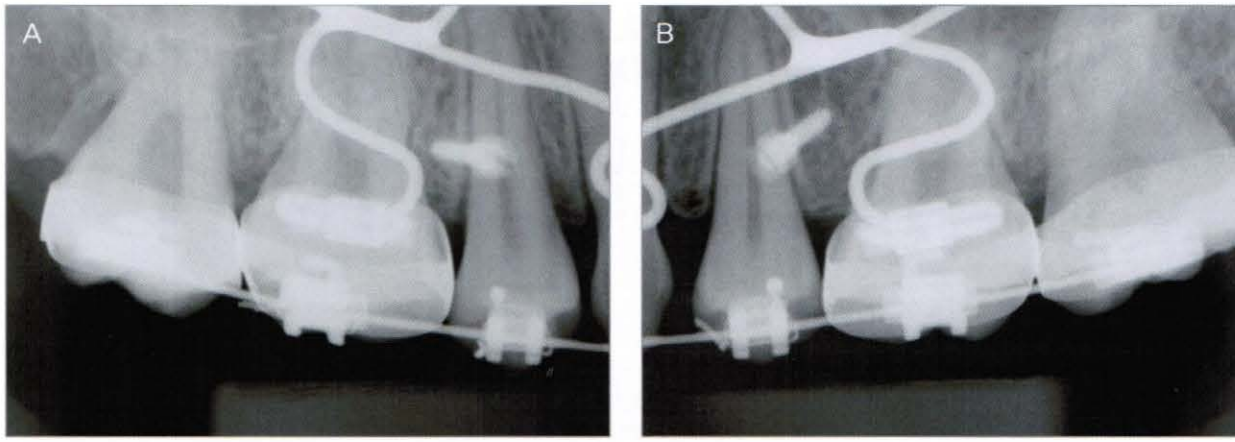


Figure 2-1-21. Intraoral photographs with mini-implants inserted. Upper palatal and lower buccal mini-implants have been inserted.



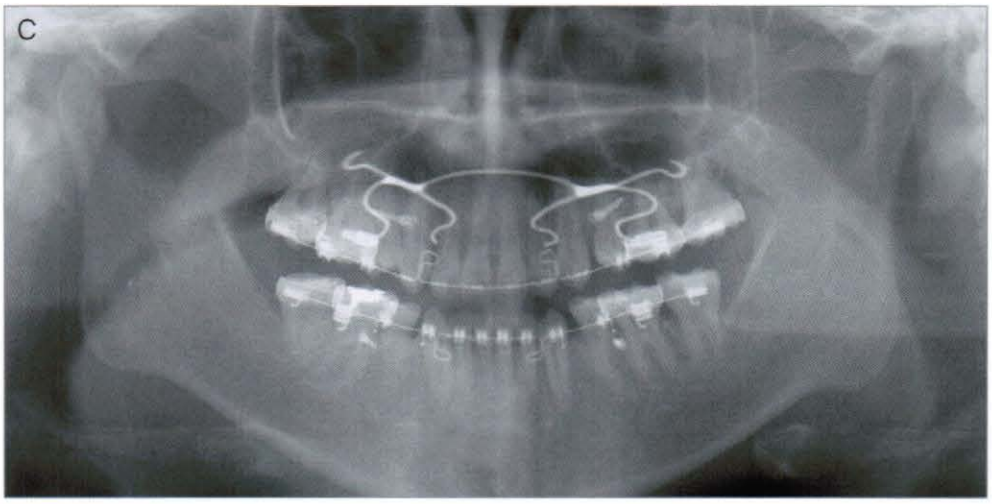


Figure 2-1-22. Confirmation of inserted mini-implant
A, B. Periapical radiographs were used to confirm the correct insertion of mini-implant between roots.
C. Lower mini-implant has also been well implanted.

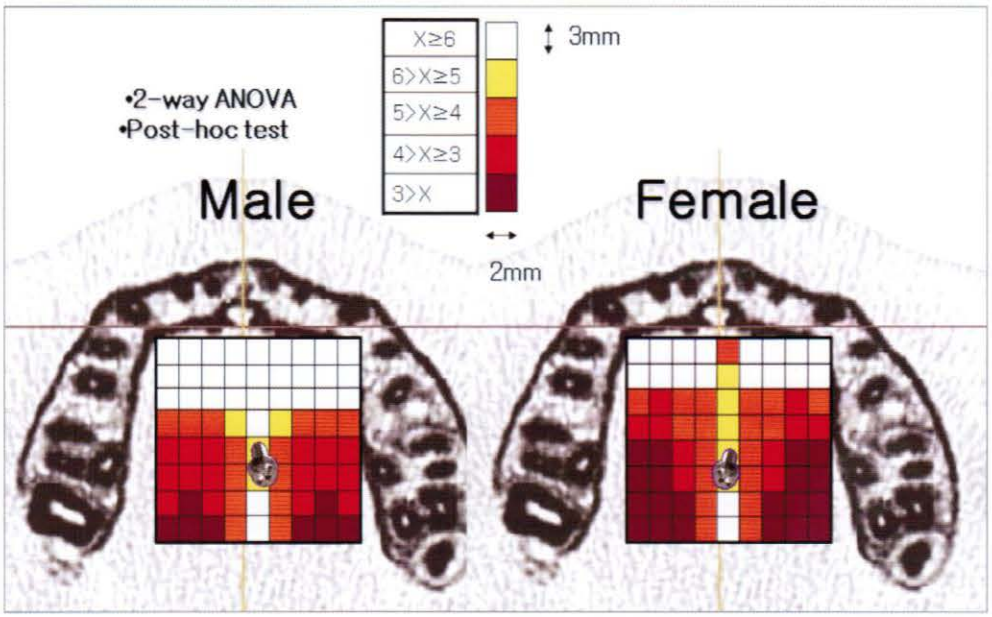


Figure 2-1-23. Thickness of bone in the midpalatal and surrounding areas were measured according to the insertion angle of the mini-implant. White and yellow areas show safe implantation thickness. Use lengths below 6mm, and take care not to deviate more than 2mm laterally from the midpalatal suture.
「Refer to : Sungmin Kang, Shin-Jae Lee, Sug-Joon Ahn, Min-Suk Heo, Tae-Woo Kim. Bone Thickness of the Palate for Orthodontic Mini-implant Anchorage, Am J Orthod Dentofacial Orthop 2007:131(4)-Supplement 1:74-81.」

Clinical tip ››››

After leveling with Roth set-up brackets, what is the recommended insertion site of mini-implants?

<Buccal> 1.6x6mm (Figure 2-1-24A)

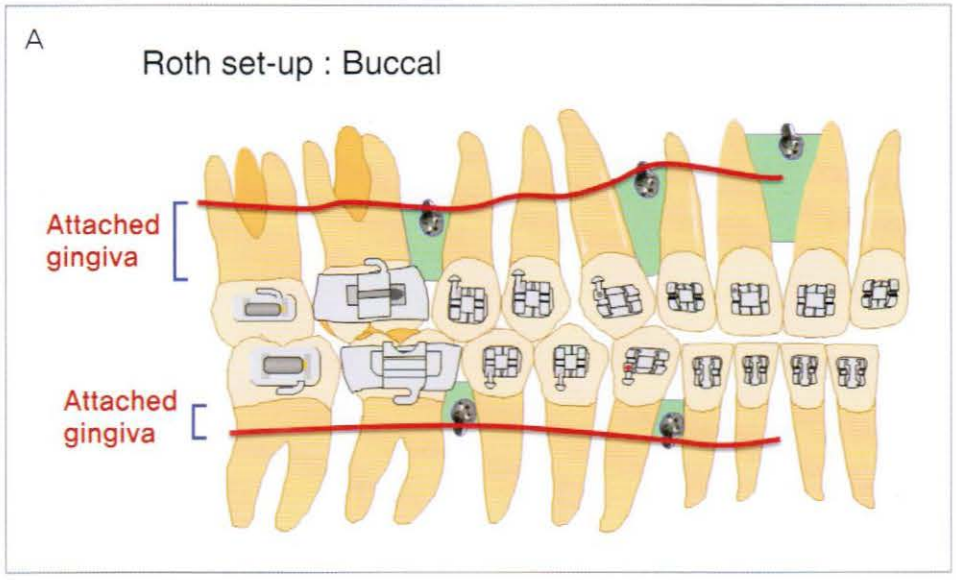
Insert as far down towards the root apex where the interradicular space is wider, but keeping in the attached gingiva.

1) Interradicular space between upper second premolar and first molar
2) Interradicular space between upper lateral incisor and canine
3) Interradicular space between central incisors (closed type)
4) Interradicular space between lower second premolar and first molar
5) Interradicular space between lower lateral incisor and canine

<Palatal> 1.6x8.0mm or 10mm (Figure 2-1-24B)

Insert close to the root apex where the interradicular space is wider. Locate the level of the maxillary sinus and take care not to penetrate.

1) Interradicular space between upper second premolar and first molar
2) Interradicular space between upper first and second molar



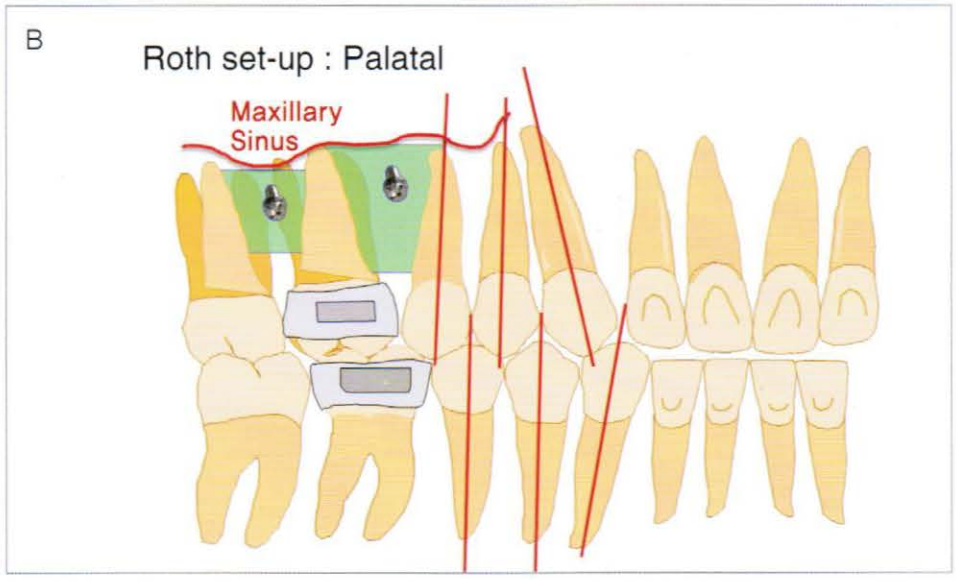


Figure 2-1-24. Recommended areas for mini-implant insertion after leveling with Roth set-up brackets
A. Labial and buccal
B. Lingual and palatal

Ⅱ. Interradicular space between second premolar and first molar

i) Buccal

The most common reasons for failure of mini-implants are:

1) Encroachment into the periodontal ligament or contact with the root surface (Figure 2-2-1)

2) Proximity to the alveolar crest (Figure 2-2-2)

Good selection of insertion area is important.

When a mini-implant encroaches into the periodontal ligament space or makes contact with the root surface, masticatory forces are transmitted onto the mini-implant through the root which causes trauma to the mini-implant and subsequent failure (Figure 2-2-1). Do not be obliged to insert a mini-implant into too narrow a space. Even when the interradicular space is wide enough, Kim's stent can be used for precise insertion. Also when the mini-implant is inserted too close to the alveolar crest, bending of the alveolar crest from tooth movement will cause trauma to the mini-implant and subsequent failure (Figure 2-2-2).

Therefore for mini-implant insertion into the buccal interradicular area, the space between roots must be sufficiently wide enough. At least 1mm of space is required from the mesial or distal surface of the root. Vertically, the mini-implant should be inserted in attached gingiva but as far towards the apex of the tooth as possible to increase stability.

The space between upper second premolar and first molar (Figure 2-1-1) is the most preferred site. A detailed explanation of inserting into this area will be given. The same method can be used for insertion into any other interradicular area of the maxillary buccal area.

Many methods have been introduced regarding safe mini-implant insertion techniques. The most common method is the brass wire[1] (Figure 2-2-3A) or metal indication[2, 3] method. However these methods are not accurate because changing the horizontal angle of the x-ray beam will change the observed distance from the adjacent tooth (Figure 2-2-3B, C). Dr. Suzuki's adjustable surgical guide[4] has resolved this problem, but lacks stability because the appliance must be attached to the archwire. Other disadvantages include its large size, the need to manufacture or buy individual guides to match various mini-implant types, and the difficulty in keeping to the x-ray taking conditions. In contrast Kim's stent[5] introduced here, is a guide which can accurately place mini-implants between roots, is easy to fabricate in the clinic, and increases the success rate by decreasing the chances of root damage.

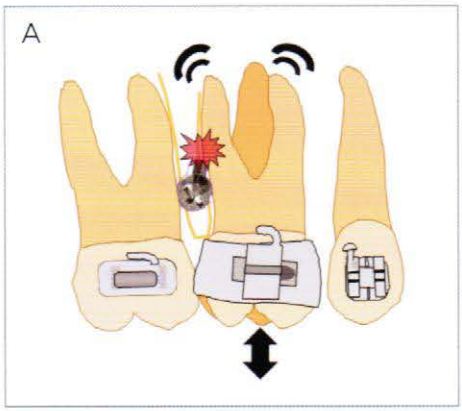


Figure 2-2-1. With encroachment into the periodontal ligament or with root contact, masticatory forces are transmitted onto the mini-implant through the root which causes trauma to the mini-implant and subsequent failure.

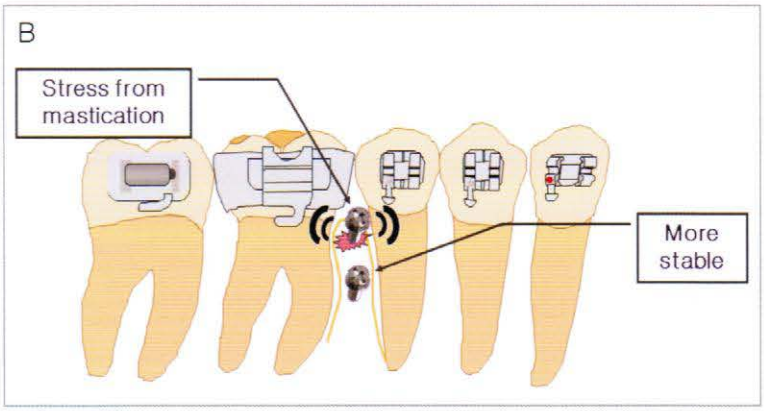


Figure 2-2-2. Proximity to the alveolar crest causes a higher mini-implant failure rate. When a mini-implant is inserted too close to the alveolar crest, the bone bends according to movement of the tooth. The implant experiences trauma which may be a cause of failure. When placed close to the tooth apex, it is more stable as it is not affected as much by tooth movement or alveolar bone bending.

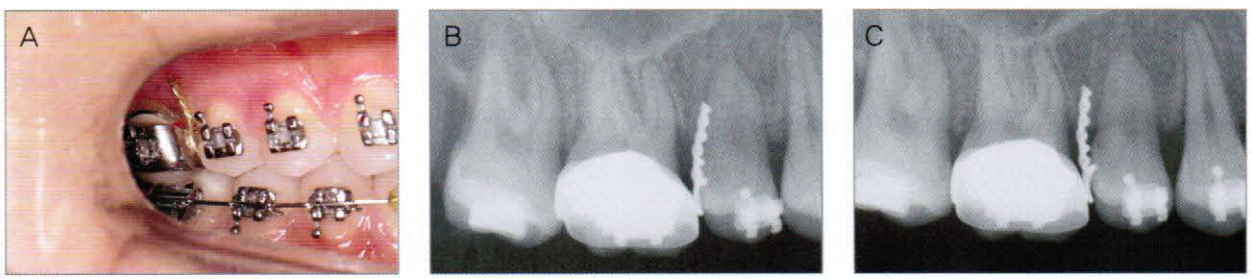


Figure 2-2-3. Brass wire method
A. Brass wire inserted between second premolar and first molar.
B, C. Even with the same brass wire, the radiograph looks different when the horizontal angle of the x-ray beam is changed.

1. Structure of Kim's stent (Figure 2-2-4)

1) Direction guide (Figure 2-2-5)

The Direction guide decides the direction of implant placement. It is ligated onto the second premolar bracket, and is placed at the midpoint between the second premolar and first molar. The wire piece lying on the occlusal surface is called the occlusal arm (Figure 2-2-5). It passes the contact point of the two adjacent teeth in close contact and approximates the proximal surface. Instructions are given for the periapical radiograph to be taken with the horizontal angulation of the x-ray beam lying parallel to this occlusal arm.

2) Positioning gauge (Figure 2-2-6)

This helps to set the mesio-distal position of the mini-implant.

Vertical arm: vertical portion of the Positioning gauge (Figure 2-2-6A)

Horizontal arm: 5-8 pieces of wire acting as a gauge are welded at 1mm intervals (Figure 2-2-6B).

Materials and instruments

- 022" bracket (MBT, 3M-Unitek)
- Study model – impression is taken with the archwire removed. Clear views of the buccal vestibule are required.
- Periapical radiograph – this must be taken so that the adjacent teeth are not overlapped (Figure 2-2-7A). The panoramic radiograph is not accurate enough (Figure 2-2-7B). 3D CT is helpful but high exposure to radiation and high cost are a disadvantage. CT is not required for Kim's stent.
- 0125x028" stainless steel wire (Jinsung, Seoul, Korea) – a thick rectangular wire with no play in the bracket must be used for stability during x-ray taking.
- 014" Elgiloy wire (green, Rocky Mountain) – easily welded onto 0215x028" stainless steel wire.
- Welder
- 043CK Kim's Plier
- Cutter
- Marker

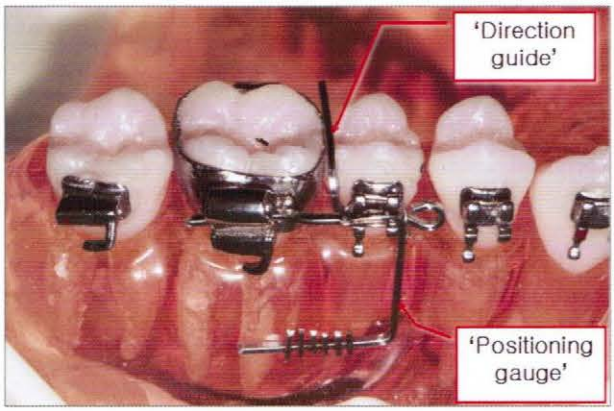


Figure 2-2-4. Structure of Kim's stent
Made up of a Direction guide and Positioning gauge. The Direction gauge is ligated onto the second premolar. The Positioning gauge is inserted into the first molar tube.

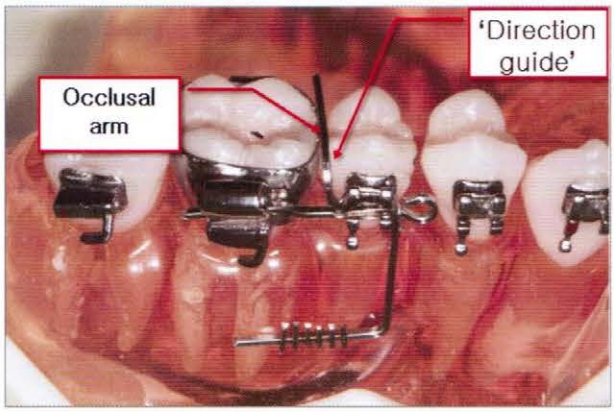


Figure 2-2-5. Structure of the Direction guide
The wire extended onto the occlusal surface of the second premolar and first molar is called the occlusal arm. This helps to decide the direction of implant insertion.

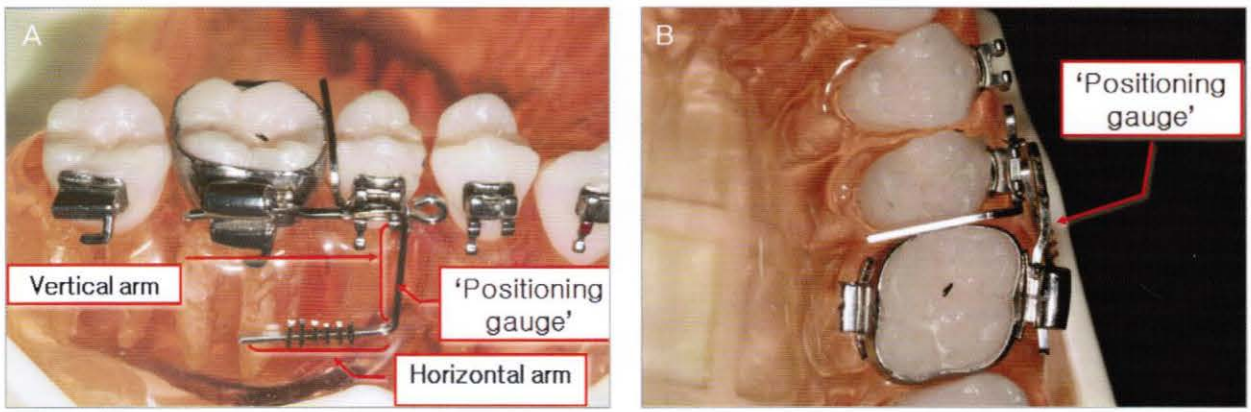


Figure 2-2-6. Structure of Positioning gauge
This helps to set the mesio-distal position of the mini-implant.
A. Vertical arm : the vertical portion of the Positioning gauge, Horizontal arm : 5~8 pieces of wire acting as a gauge are welded at 1mm intervals.
B. A bayonet bend has been included at the mesial end of the buccal tube of the Positioning gauge to stop it from hitting the second premolar bracket. It also stops the Positioning gauge from being pushed back.

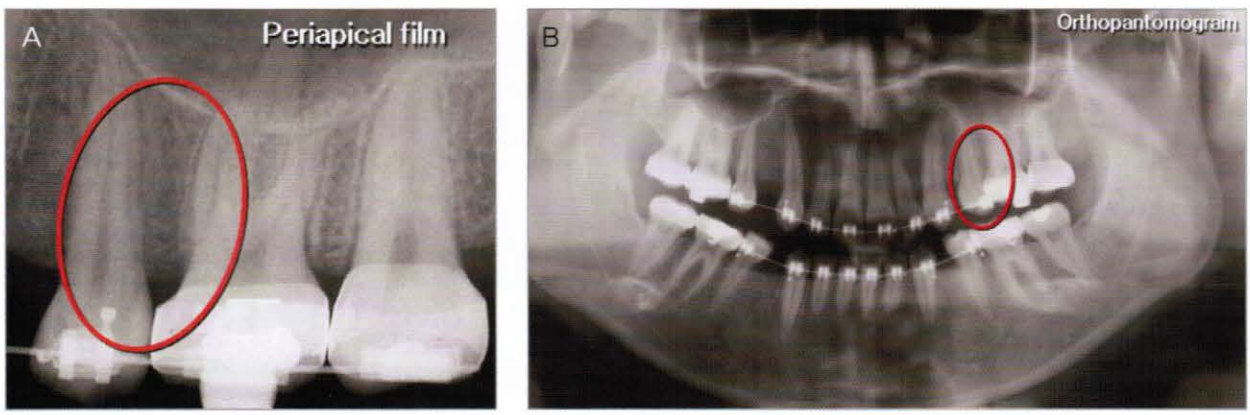


Figure 2-2-7. A periapical radiograph is taken so that the contact points of adjacent teeth do not overlap (A). The panoramic radiograph is not accurate enough (B). Area with the circle shows that the adjacent teeth are shown overlapped.

2. Manufacture of Kim's stent

After leveling, a periapical radiograph is taken. The periapical radiograph should be taken so that the contact areas of adjacent teeth are not overlapped. The archwire is removed before an impression is taken. The buccal vestibule must be clearly visible. The model and x-ray are used to tentatively decide on the position and direction of the mini-implant. 022" bracket (MBT, 3M-Unitek, California, USA) and 0215x028" stainless steel wire (JinSung, Seoul, Korea) are used.

1) Direction guide

The Direction guide is ligated to the bracket of the tooth mesial to the point of insertion (Figure 2-2-5). In this case it is the second premolar. A tag to act as a stop is bent mesial to the second premolar bracket (Figure 2-2-8A). From the middle of the contact area between the second premolar and first molar, the wire is bent in the occlusal direction (Figure 2-2-8B). On the occlusal surface, the occlusal arm is bent to contact the proximal area of the adjacent tooth while passing through the contact point (Figure 2-2-8C).

View from the occlusal surface to check whether it has been constructed correctly (Figure 2-2-8D). This occlusal arm is the direction of mini-implant insertion. Also, the x-ray beam's horizontal angle is brought in line with the occlusal arm.

2) Positioning gauge

The Positioning gauge is ligated to the bracket of the tooth distal to the mini-implant insertion site (Figure 2-2-6A, B). First, 5 to 8 pieces of 014" Elgiloy wire (Rocky Mountain Orthodontics, Colorado, USA) are welded onto the Horizontal arm of the Positioning gauge at 1mm intervals (Figure 2-2-9A, B). The wire pieces are cut leaving around 3mm (Figure 2-2-9C). Position the pins so that the center matches the estimated position of the mini-implant, and then bend the Vertical arm (Figure 2-2-9D). The position of the Vertical arm is at the center of the second premolar bracket. The wire is bent 90° at the height of the second premolar bracket (Figure 2-2-9E). A bayonet bend is bent at the mesial end of the first molar tube or bracket to act as a stop (Figure 2-2-9F). The bayonet bend also stops the Positioning gauge and Direction guide from hitting the second premolar bracket (Figure 2-2-9G, Fig 2-2-6B).

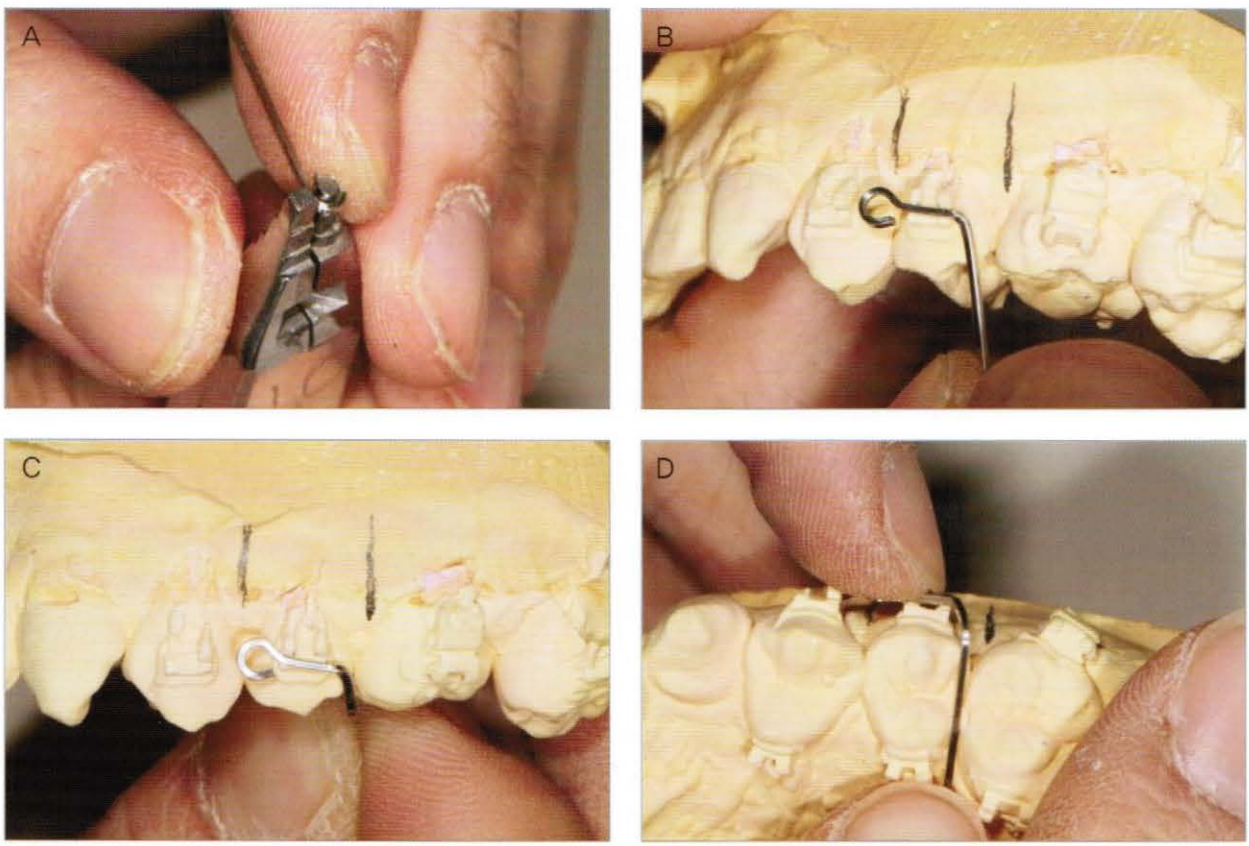


Figure 2-2-8. Construction of the Direction guide
A. A tag is bent at the mesial end of the second premolar bracket to act as a stop.
B. The wire is bent in the occlusal direction at the contact point between the second premolar and first molar.
C. The occlusal arm is bent to contact the proximal area while passing through the center of the contact point of the two adjacent teeth.
D. Check from the occlusal surface to confirm the direction of the arm. This occlusal arm shows the direction of mini-implant insertion. Also, the x-ray beam's horizontal angle is brought in line with the occlusal arm.

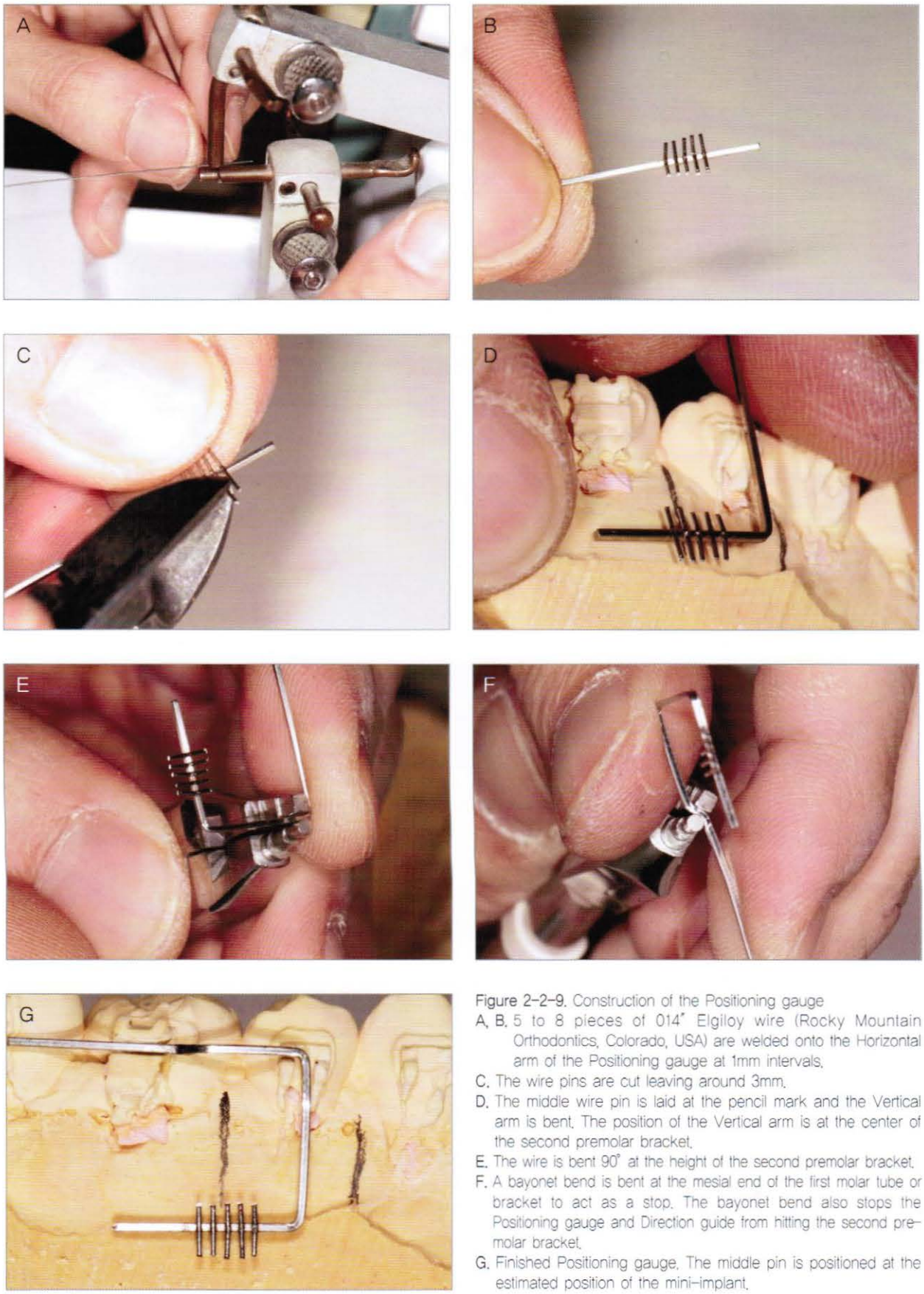


Figure 2-2-9. Construction of the Positioning gauge
A, B. 5 to 8 pieces of 014" Elgiloy wire (Rocky Mountain Orthodontics, Colorado, USA) are welded onto the Horizontal arm of the Positioning gauge at 1mm intervals.
C. The wire pins are cut leaving around 3mm.
D. The middle wire pin is laid at the pencil mark and the Vertical arm is bent. The position of the Vertical arm is at the center of the second premolar bracket.
E. The wire is bent 90° at the height of the second premolar bracket.
F. A bayonet bend is bent at the mesial end of the first molar tube or bracket to act as a stop. The bayonet bend also stops the Positioning gauge and Direction guide from hitting the second premolar bracket.
G. Finished Positioning gauge. The middle pin is positioned at the estimated position of the mini-implant.

3. Fixation of Kim's stent and x-ray taking

Kim's stent is first fixed in the patient's mouth. The Direction guide is ligated onto the second premolar. If required, the Occlusal arm is adjusted at this point. The Positioning gauge is then ligated after adjustments. We must check whether the gauge of the Horizontal arm interferes with insertion of the mini-implant. The gauge should be placed around 2mm above the border of the attached and vestibular gingiva (Figure 2-2-10). This makes sure that it does not interfere with mini-implant insertion.

During x-ray taking, the occlusal arm of the Direction guide and the horizontal angle of the x-ray beam should be parallel (Figure 2-2-11). In an ideal periapical radiograph, the contact point of the second premolar and first molar is clearly visible, and the crowns do not overlap (Figure 2-2-12). In figure 2-2-12, the third pin from the right is at the center of the interradicular space between the second premolar and first molar (Figure 2-2-12). This is the point of implant insertion (Figure 2-2-13A).

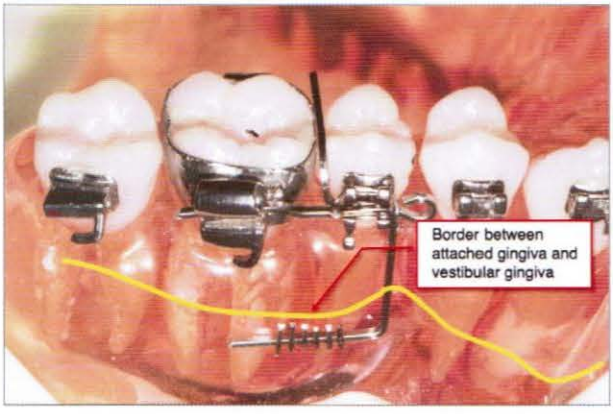


Figure 2-2-10. Level of the horizontal arm
The pins on the gauge should not interfere with the mini-implant. The pins should be placed around 2mm towards the vestibule from the border of the attached and vestibular gingiva.

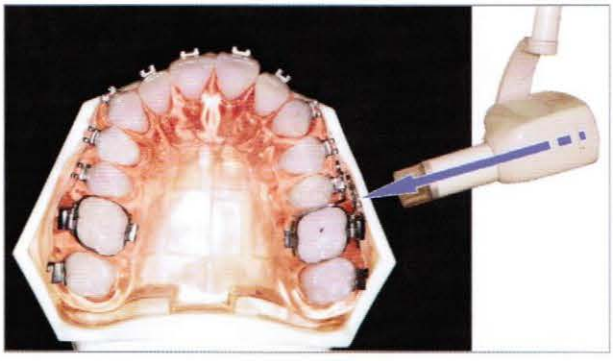


Figure 2-2-11. The most important factor during x-ray taking
The horizontal angle of the x-ray beam and the occlusal arm of the Direction guide should be parallel.

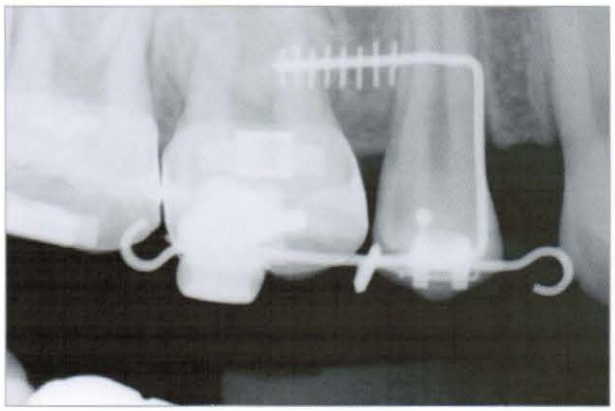


Figure 2-2-12. Periapical radiograph with Kim's stent in place
In an ideal situation, the contact point between the second premolar and first molar is clearly seen and the proximal surfaces of adjacent teeth do not overlap.

4. Mini-implant insertion

After disinfection of the oral cavity and mouth region, the required instruments and materials are prepared. In the area of insertion, 1/4 or 1/3 ampule of lidocaine is injected for local anesthesia. From the several pins on the Positioning gauge of Kim's stent, a pin positioned at the center of the two adjacent teeth is chosen (Figure 2-2-12, third pin from the right). This determines the mesio-distal position of mini-implant insertion. The soft tissue is marked with an explorer, and at the same time the thickness is determined. Also when the cortical bone is deficient or thin, the explorer will be pushed in without resistance, and in these cases, the prognosis is poor. This is often seen in young patients, and the failure rate is high.

The mini-implant is inserted in the highest point of the attached gingiva, perpendicular to the gingival surface (up to 30° if required) (Figure 2-2-13A). To insert at an angle, a 15 ~ 30° angle can be given after the mini-implant has pierced the cortical bone. An angle any higher needs the use of the drilling method.

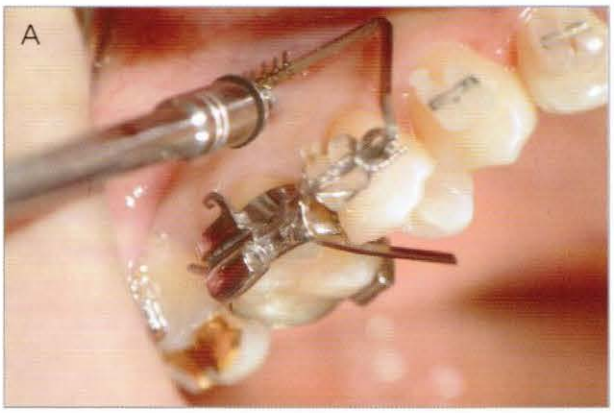
When viewed from the occlusal surface, the axis of the hand driver and the occlusal arm of the Direction guide should be parallel (Figure 2-2-13B). Using a large dental mirror (Figure 2-2-13C) from the occlusal surface will be helpful. Smaller dental mirrors have a narrower field of view and precise determination is difficult.

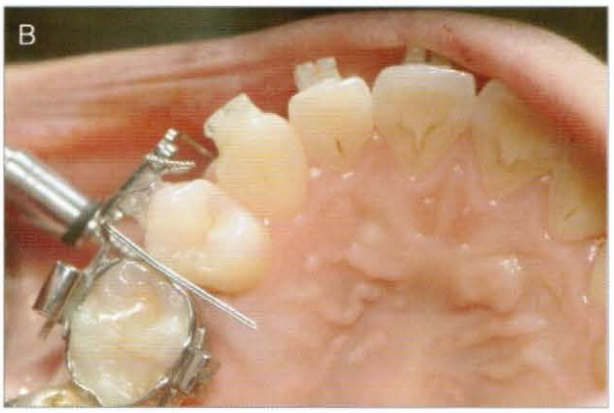
Use a hand driver and a 1.6x6mm mini-implant. For the space between the first and second molar, the narrower space requires a contra-angle handpiece and bur-type wrench (113-MJ-203) (Figure 2-2-13E, F).

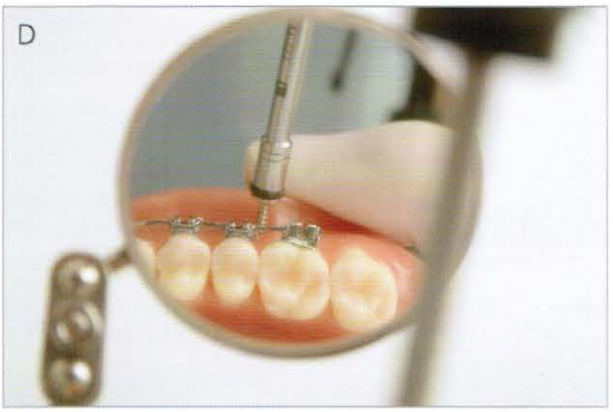
Clinical tip ››››

The most important points during use of Kim's stent

1) After ligation of Kim's stent and during x-ray taking, the occlusal arm of the Direction guide and the horizontal angle of the x-ray beam should be parallel. In an ideal periapical radiograph, the contact point of the second premolar and first molar should be clear and the proximal surfaces should not be overlapped (Figure 2-2-12).
2) Looking from the occlusal surface, the axis of the hand driver and the occlusal arm of the Direction guide should be parallel (Figure 2-2-13B).
3) During actual insertion, the central axis of the hand driver should be stable without jiggling.







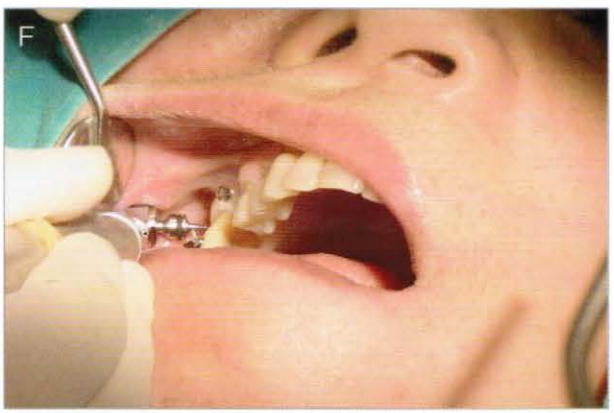


Figure 2-2-13. Mini-implant insertion

A. Mini-implant is inserted at the highest point in the attached gingiva at the selected pin location.

B. Looking from the occlusal surface, the axis of the hand driver and occlusal arm of the Direction guide should be parallel.

C. Standard dental mirror and large sized dental mirror (top : Rotating round mirror, Kwangmyung Daicom Co., Ltd., Seoul, Korea).

D. Occlusal surface observed through large dental mirror. Easy to view whether the hand driver axis and occlusal arm are parallel. Standard dental mirrors have a narrower field of view and precise determination is difficult.

E. When implanting between the first and second molar, the tight work area requires a contra-angle handpiece and short bur-type wrench (113-MJ-203) to be used.

F. A mini-implant is being inserted distal to the second molar. A contra-angle handpiece and short bur-type wrench are being used in the tight work space.

Immediately after insertion, a periapical radiograph is taken in the same way to check whether the mini-implant has been inserted in the correct position. If incorrect, it is immediately re-inserted. For this reason, Kim's stent should be left in place during the final x-ray. When damage to the root or encroachment into the PDL space is suspected, it is immediately removed and re-inserted. Figure 2-2-14 shows the mini-implant inserted correctly in the interradicular space.

Advantages of Kim's stent

The position and direction of mini-implant insertion is established from the periapical radiograph and study model. Kim's stent is ligated, and with a second radiograph, final adjustments are made. The frequency of contact rate between root and implant is markedly decreased. Other advantages include:

1. Easy fabrication.
2. Low cost. It is easily fabricated using materials already in the clinic.
3. It can be used with a variety of implant types.
4. The interradicular space can be measured using a radiograph.
5. The position on the model and radiograph can be directly reproduced in the patient.
6. Errors due to change in x-ray angle can be kept to a minimum.
7. If root contact occurs, mini-implant can be immediately re-directed and re-inserted.

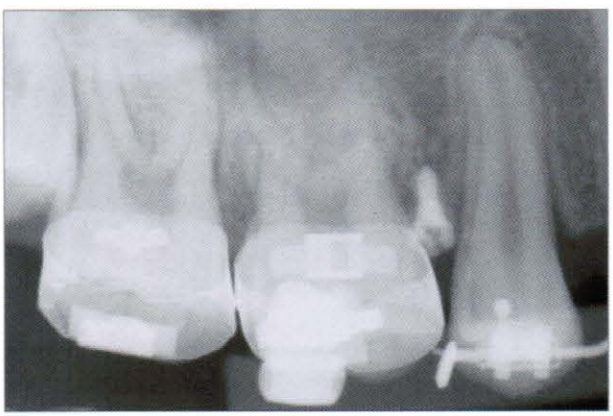


Figure 2-2-14. Radiograph with mini-implant in place

Case A (Figure 2-2-15)

Because the mini-implant showed mobility, radiographs were taken at various angles. They showed that the mini-implant inserted between the right second premolar and first molar was in contact with the mesial root of the first molar (Figure 2-2-15A, B). The mini-implant was removed and a periapical x-ray taken with Kim's stent in place (Figure 2-2-15C). The 4th pin from the right was chosen and mini-implant inserted at this point (Figure 2-2-15D). A defect remains on the mesial surface of the first molar root. Even in a narrow interradicular space, Kim's stent allows accurate adjustment and placement.

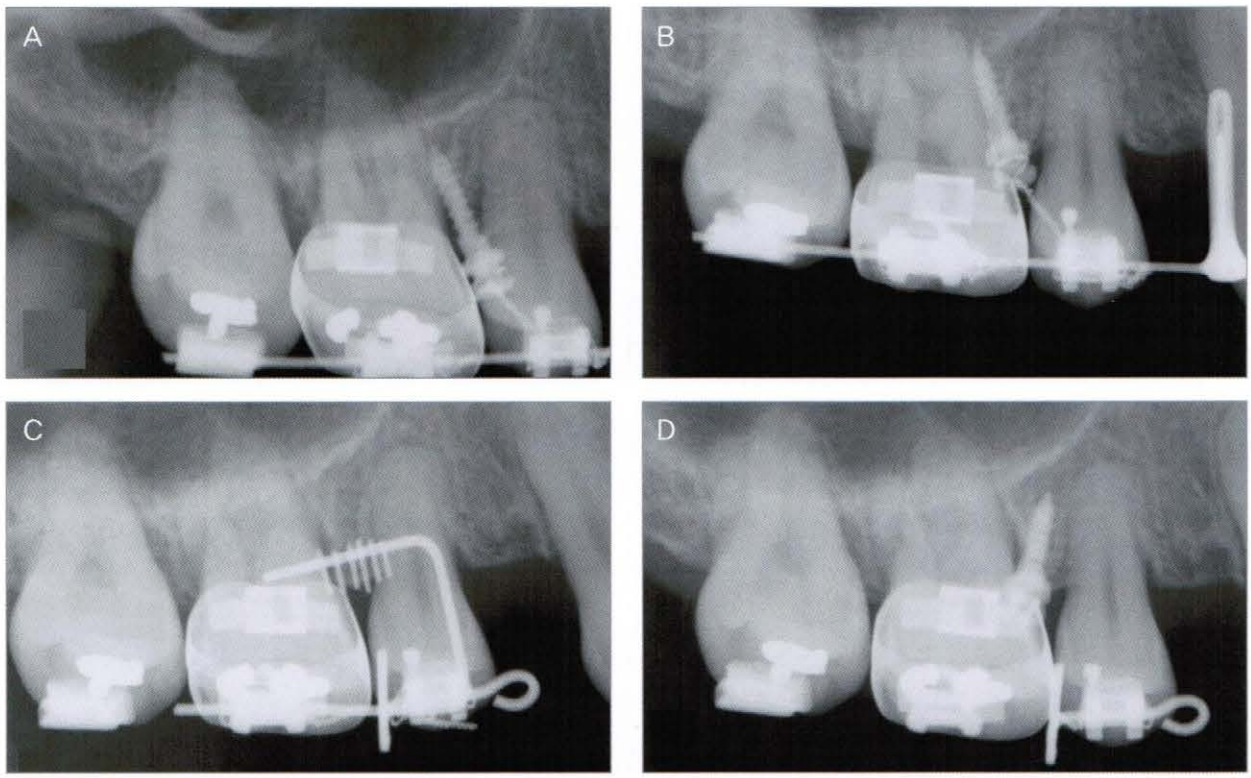


Figure 2-2-15. Case A

A, B. Because the mini-implant showed mobility, radiographs were taken at various angles. They showed that the mini-implant inserted between the right second premolar and first molar was in contact with the mesial root of the first molar.

C. The mini-implant was removed and a periapical x-ray taken with Kim's stent in place. The 4th pin from the right was chosen and mini-implant inserted at this point.

D. Even in a narrow interradicular space, Kim's stent allows accurate adjustment and placement. A defect remains on the mesial surface of the first molar root.

Case B (Figure 2-2-16)

A narrow space between the upper left first and second premolar was attempted (Figure 2-2-16A). With Kim's stent in place, a periapical radiograph was taken. The midpoint between the 3rd and 4th pin from the right was chosen as the point of insertion (Figure 2-2-16B).

Figure 2-2-16C shows the mini-implant inserted exactly midway between the two roots.

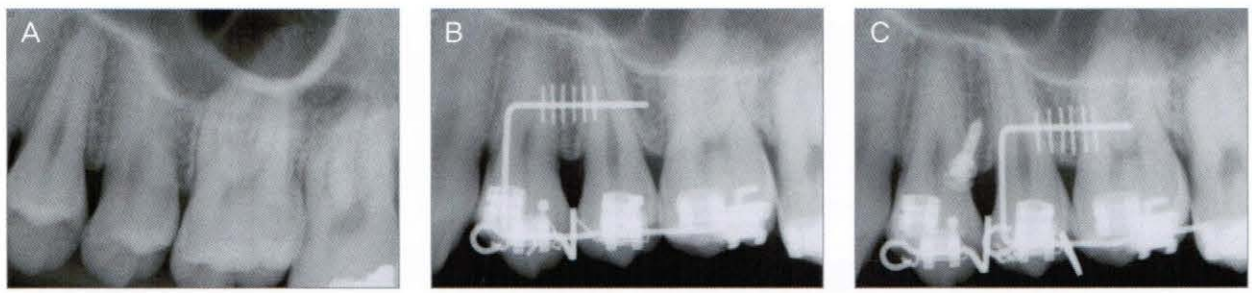


Figure 2-2-16. Case B

A. A narrow space between the upper left first and second premolar was attempted.

B. With Kim's stent in place, a periapical radiograph was taken. The midpoint between the 3rd and 4th pin from the right was chosen as the point of insertion.

C. The mini-implant has been inserted exactly midway between the two roots. Another Kim's stent is in place for mini-implant insertion between the first molar and second premolar.

Case C (Figure 2-2-17)

This shows the right side of the patient in Case 13 (page 315) . A periapical radiograph was taken for implantation between the second premolar and first molar (Figure 2-2-17A). Kim's stent was ligated and the mid-point between the second and third pin from the right was chosen as the insertion point (Figure 2-2-17B). After insertion, correct placement is verified (Figure 2-2-17C).

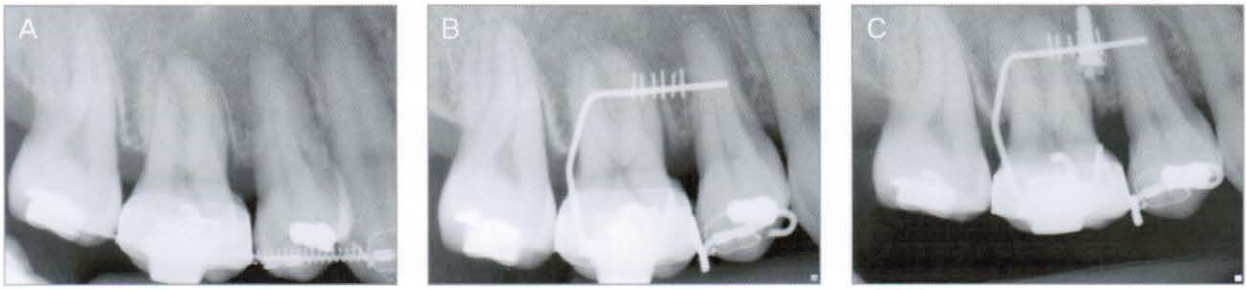
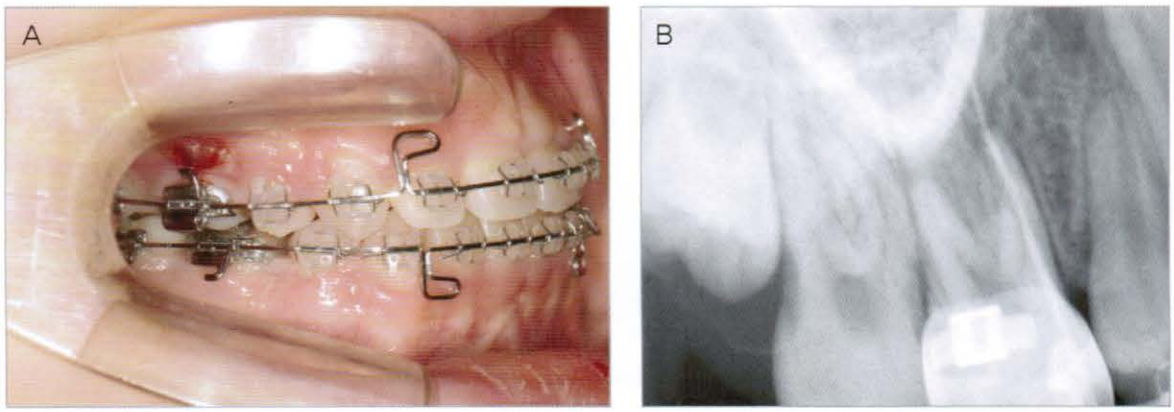


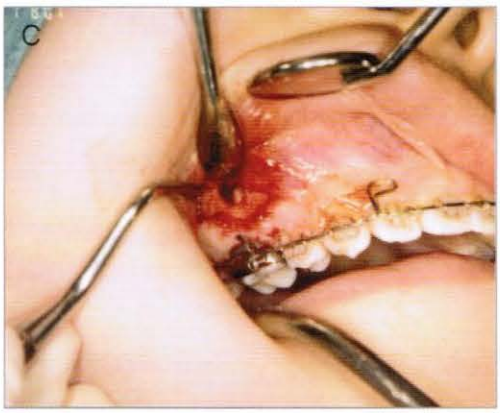
Figure 2-2-17. Case C
A. A periapical radiograph showing the interradicular space between the right second premolar and first molar in the patient shown in Case 13.
B. After ligation of Kim's stent, a second x-ray is taken, and the mid-point between the second and third pin from the right was chosen as the insertion point.
C. After insertion, correct placement is verified.

5. Removal of the mini-implant

Thorough disinfection is essential. Even though it is a simple procedure, if infected, it can lead to pulpitis, periapical infection or pulp necrosis. Disinfection prior to removal must be carried out in the same way as it is done during an extraction procedure. The photograph in Figure 2-2-18 shows a case where even though the mini-implant did not contact the root or periodontal ligament, infection during removal caused a periapical infection with fistula, which required endodontic treatment of the first molar.

Local anesthetic is usually not required during mini-implant removal. If the head of the implant is buried in soft tissue due to inflammation, local anesthetic can be given, the soft tissue removed, and mini-implant removed.





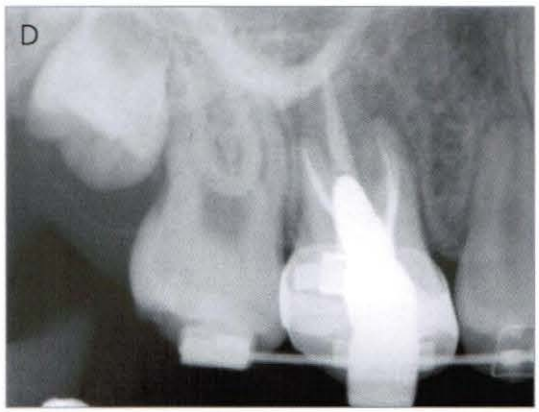


Figure 2-2-18. Pulpitis and periapical infection due to infection during mini-implant removal
A. The extraction space was closed and mini-implant removed. There was no mobility or inflammation. At the next appointment, a fistula was present.
B. The fistula extended to the periapical area of the first molar.
C. Bone loss around the periapical area is evident.
D. After endodontic treatment, the fistula has disappeared.

Clinical tip ››››

Summary of instructions for buccal or labial interradicular mini-implant insertion

- Mini-implant is inserted in the attached gingiva (Figure 2-1-1). Implanting in movable mucosa should be avoided. When it is inevitable, the head should not be left open ("open type") but covered with a flap so that the head is not exposed into the oral cavity ("closed type", Figure 2-1-6 shows an example). In cases where the mini-implant is inserted as an open type in movable mucosa, the patient experiences much discomfort and ulceration, and the hyperplasia of surrounding soft tissue will cover the head.
- Mini-implant is inserted perpendicular to the mucosa and cortical bone. In situations where the attached gingiva is too narrow, giving an angle of up to 30° will do no harm. The angle of insertion can be changed after the initial piercing of cortical bone. With the non-drilling method, it is difficult to begin inserting at an angle. An angle any higher needs the use of the drilling method.
- On periapical radiograph, an interradicular distance of at least 3.6mm is required for mini-implant insertion. In his research, Dr. Eric Liou[6] has stated that the distance between mini-implant and root should be at least 2mm. However in clinical situations, these ideal circumstances are hard to come by. A distance of around 3.6mm should be wide enough for insertion of a 1.6mm diameter mini-implant.
- The adjacent teeth should not be overlapped on periapical radiograph. Panoramic radiographs cannot accurately assess interradicular distances because of distortion and overlapping of teeth. CT can be used adjuctly.
- Mini-implant should be inserted after leveling. Except for cases with abnormal tooth shape, leveling allows the attainment of uniform interradicular distances. On radiograph, the contact area will be clearly seen without overlapping. If the mini-implant is inserted early, the roots may move during leveling and touch the mini-implant.
- Use Kim's stent[5]. By adjusting the direction and insertion position of the mini-implant on radiograph and dental model, accurate placement is possible with less damage to the roots.

ii) Palatal

As mentioned in the anatomic considerations section of Chapter 2, the distance between the palatal roots is fairly wide. A few points of considerations are mentioned.

1. Periapical radiograph. Taken so that the adjacent teeth do not overlap. Carefully observe palatal root form and estimate interradicular distance. If the radiograph is not clear, a CT may be needed.
2. Insertion distance from the gingival margin. In contrast to the buccal area, there is no limit to the attached gingiva. But pneumatization of the maxillary sinus must be checked.
3. Marking and soft tissue thickness measurement. While marking the insertion area with an explorer, the soft tissue thickness is measured (Figure 2-2-19A). If the soft tissue is thick, a 10mm rather than an 8mm length mini-implant is used.
4. Direction of implantation. Observe from the occlusal surface.
5. Instruments. Use a contra-angle handpiece with a bur-type wrench (Figure 2-2-19B).
6. Failure rate. Stability is much higher than buccal mini-implants.

Figure 2-2-19. Palatal implantation
A. While marking the insertion area with an explorer, the soft tissue thickness is measured.
B. The insertion angle is checked from the occlusal surface.
C. Use a contra-angle handpiece and bur-type wrench.

Ⅲ. Incisor interradicular space : Labial

i) Between the upper central incisors (Refer to Case 9, 10 & Figure 2-3-1)

Mechanics of upper central incisor intrusion (Figure 2-3-2)

Attach brackets (022" slot) on teeth to be intruded, and insert a 019x025" ss wire in a box form as a guiding wire. This guiding wire will prevent the NiTi coil spring from impinging on the gingiva. The upper incisors will be intruded and flared labially. The method introduced in Dr. Creekmore's[8] clinical report was referenced and the method improved.

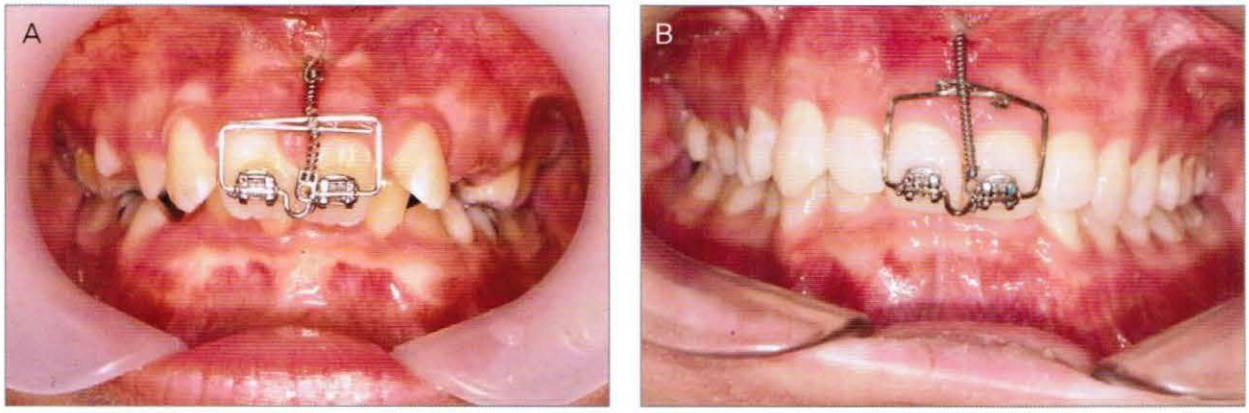


Figure 2-3-1.
A. Case 9. Intrusion of upper central incisors. A 019×025" guiding wire is used to prevent impingement of the coil spring onto the gingiva.
B. Case 10.

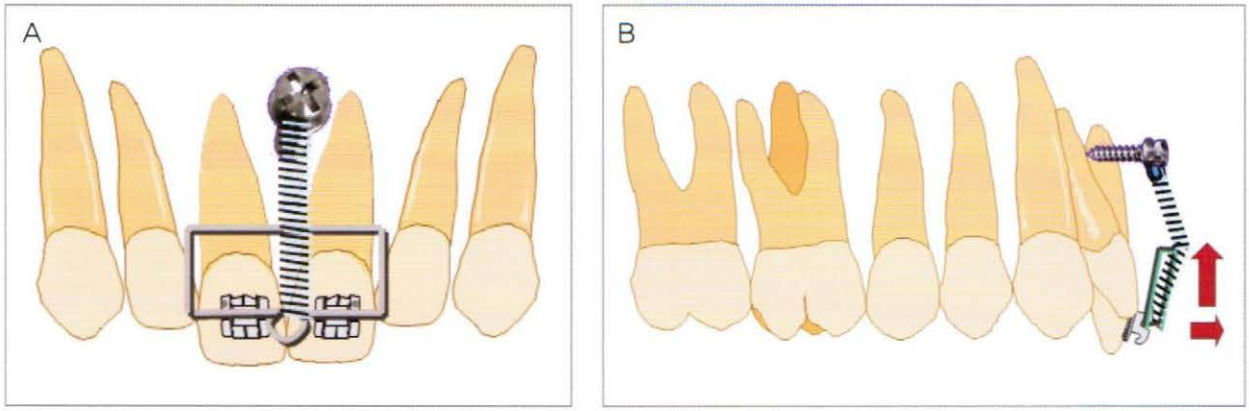


Figure 2-3-2. Mechanics of upper central incisor intrusion
A. Brackets (022") are attached to teeth to be intruded. 019×025" ss guiding wire in a box form is ligated. NiTi coil spring will pass over this guiding wire.
B. The guiding wire will prevent gingival impingement of the NiTi coil spring. The upper incisors undergo intrusion and labioversion.

Implantation procedure (Figure 2-3-3)

The procedure is very simple. Use an aseptic technique to prevent infection, and instruct the patient to gargle with chlorhexidine after every meal and keep up good oral hygiene.

1. Radiograph (Figure 2-3-3A)

   Take a periapical radiograph and check the interradicular distance.

2. Make an incision as for a frenectomy (Figure 2-3-3B)

   Pull on the upper lip using gauze. The gauze will prevent the lip from slipping out. Using no. 15 blade, the frenum is incised horizontally.

3. Confirm bone surface (Figure 2-3-3C)

   Flap is raised through an undermining incision and the periosteum is opened with a periosteal elevator. The ridge under the anterior nasal spine should be visible.

4. Saline irrigation (Figure 2-3-3D)

   The area is irrigated with saline to remove debris and blood.

5. Mini-implant insertion (Figure 2-3-3E, F)

   A 1.6x6.mm mini-implant is inserted through the non-drilling method[9, 10].

   The ridge under the anterior nasal spine can prevent the mini-implant from being placed in the center. Avoid this area by placing slightly inferior or to the side.

6. Ligature wire and NiTi coil spring (Figure 2-3-3G)

   Ligate the ligature wire to the neck of the mini-implant. Then ligate one end of the NiTi coil spring onto the ligature wire. The ligature wire and NiTi coil spring must be disinfected before the procedure.

7. Suture (Figure 2-3-3H, I)

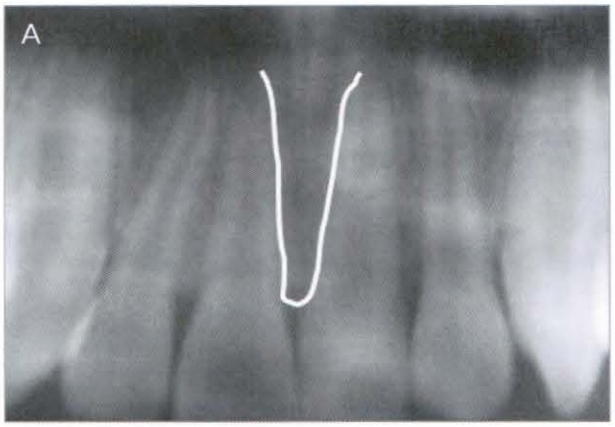
   Close the flap over the head of the mini-implant, and suture with 4.0 silk.

8. Ligation of NiTi coil spring (Figure 2-3-3J)

   Ligate the other end of the NiTi coil spring onto the archwire.

   The case shown here is an example of the "closed method" where the flap is closed over the mini-implant head.

By using the closed method, insertion into movable vestibular gingiva is possible. Also, placement of the mini-implant more towards the tooth apex is possible which lessens the chances of root contact as the interradicular distance is greater towards the apex. It is more comfortable for the patient. However, it is important to use an aseptic technique and gargling with chlorhexidine after every meal is required to prevent infection.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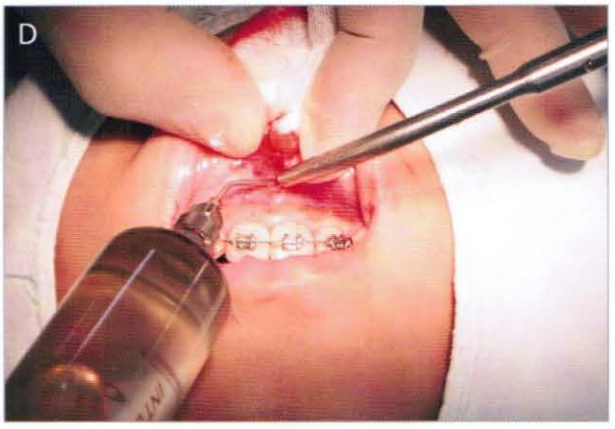
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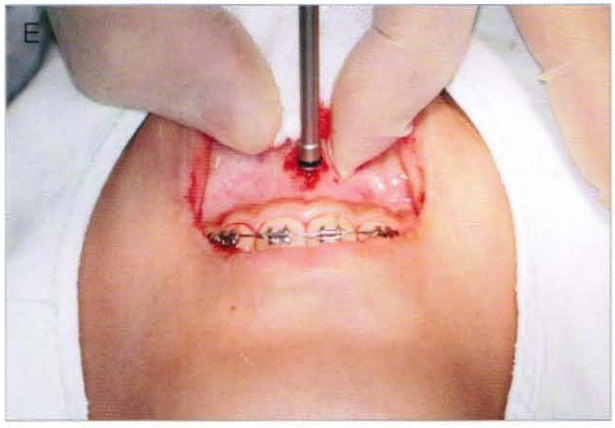
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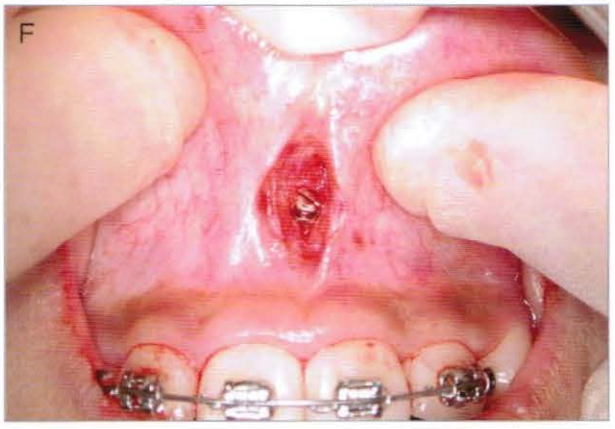
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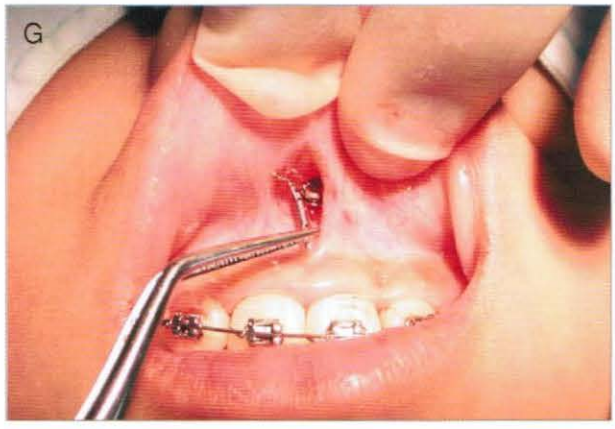
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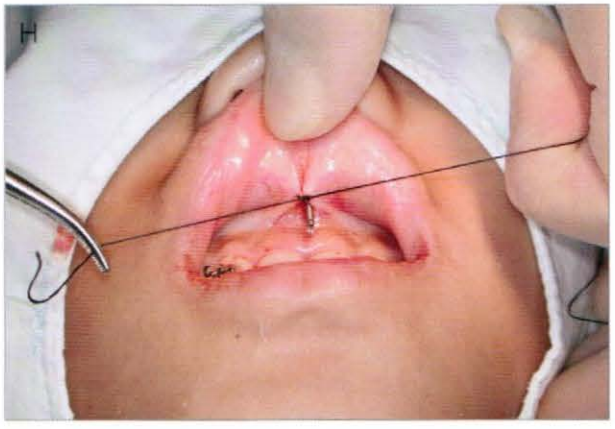
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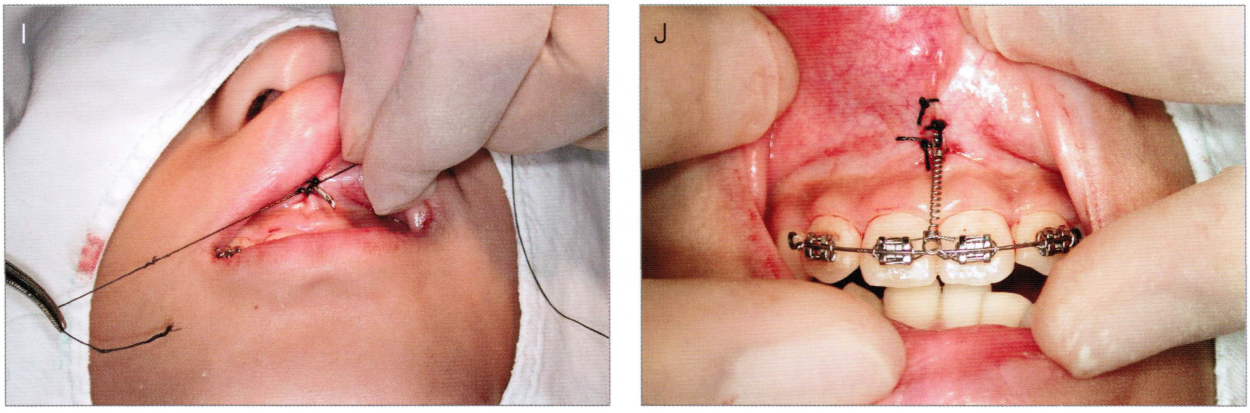

Figure 2-3-3. Using the closed method between the upper central incisors
A. Radiograph. Take a periapical radiograph or panoramic radiograph to verify the interradicular distance.
B. Make an incision as for a frenectomy. The upper lip is pulled up using gauze. No. 15 blade is used to make a horizontal incision.
C. With an undermining incision, the flap is opened, periosteum incised and opened with a periosteal elevator. The ridge under the anterior nasal spine should be visible.
D. Saline irrigation.
E. A 1.6×6.mm mini-implant is inserted through the non-drilling method.
The ridge under the anterior nasal spine can prevent the mini-implant from being placed in the center. Avoid this area by placing slightly inferior or to the side.
F. The mini-implant has been inserted.
G. Ligate a ligature wire onto the neck of the mini-implant. Then ligate one end of the NiTi coil spring onto the ligature wire.
H, I. Close the flap over the head of the mini-implant, and suture with 4.0 silk.
J. Ligate the other end of the NiTi coil spring onto the archwire.

ii) Between the lateral incisor and canine (Refer to Case 4, 5, 12)

The space between the lateral incisor and canine roots is fairly wide after leveling with Roth set-up brackets. Therefore, if leveling is complete up to 016x022" NiTi, in most cases a 1.6x6mm mini-implant can easily be inserted between the lateral incisor and canine (Figure 2-3-4). This is also a good area because the attached gingiva is fairly wide. Mini-implant can be inserted safely without the use of a stent.

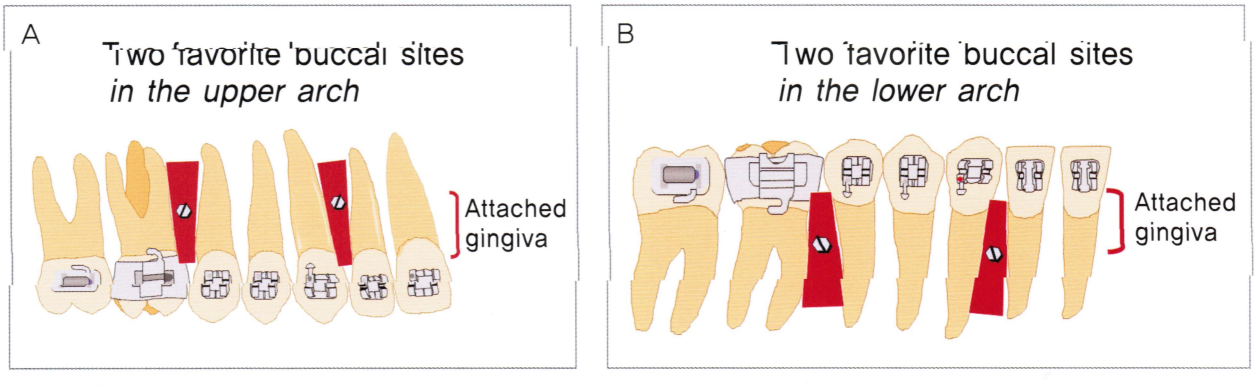

Figure 2-3-4. Preferred area for mini-implant insertion
A. Upper buccal and labial. The space between the lateral incisor and canine or second premolar and first molar are the widest after leveling. Mini-implant is inserted at the highest point on the attached gingiva.
B. Lower buccal and labial. The space between the lateral incisor and canine or second premolar and first molar are the widest after leveling. Mini-implant is inserted at the highest point on the attached gingiva. Because the attached gingiva in the mandible is narrow, good indication for insertion is hard to come by.

Implantation procedure (Figure 2-3-5, 6)

1. X-ray taking (Figure 2-3-5A, 6A)

   Measure the interradicular area between the lateral incisor and canine.

2. Disinfection and anesthesia.

3. Marking with explorer.

   The concave area between the lateral incisor root and canine root can be visualized with the naked eye. This corresponds to the central area between the roots (Figure 2-3-5B). Decide on the position of mini-implant insertion by checking the shape and position of the roots on x-ray.

4. Insertion of mini-implant

   A 1.6x6mm mini-implant is inserted through the non-drilling method (Figure 2-3-5C, 6C).

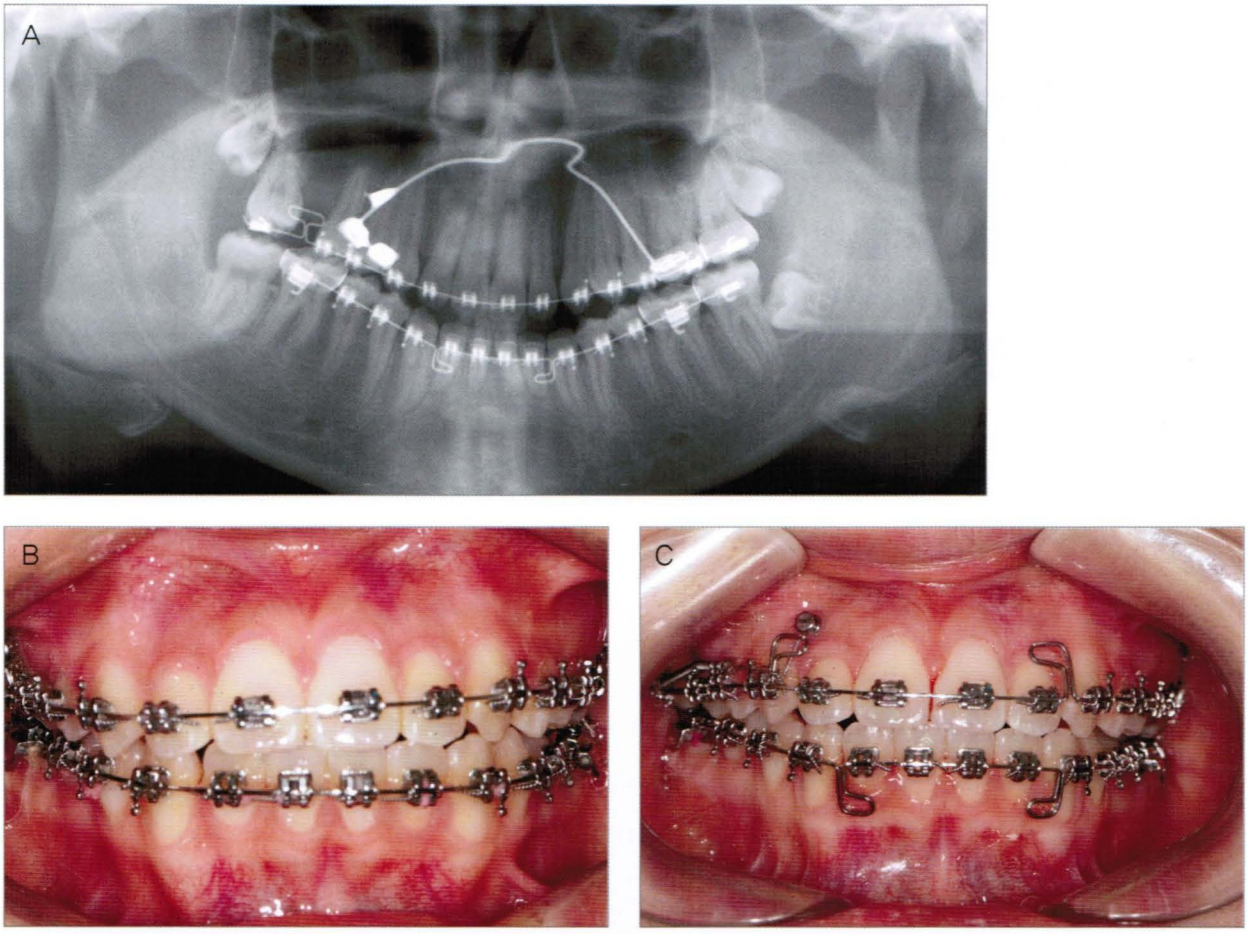

Figure 2-3-5. Case 12

A. Radiograph after leveling. The interradicular space between the upper lateral incisor and canine is fairly wide.

B. The concave area between the lateral incisor root and canine root can be visualized with the naked eye. Mini-implant is inserted in the deepest area.

C. Inserted mini-implant.

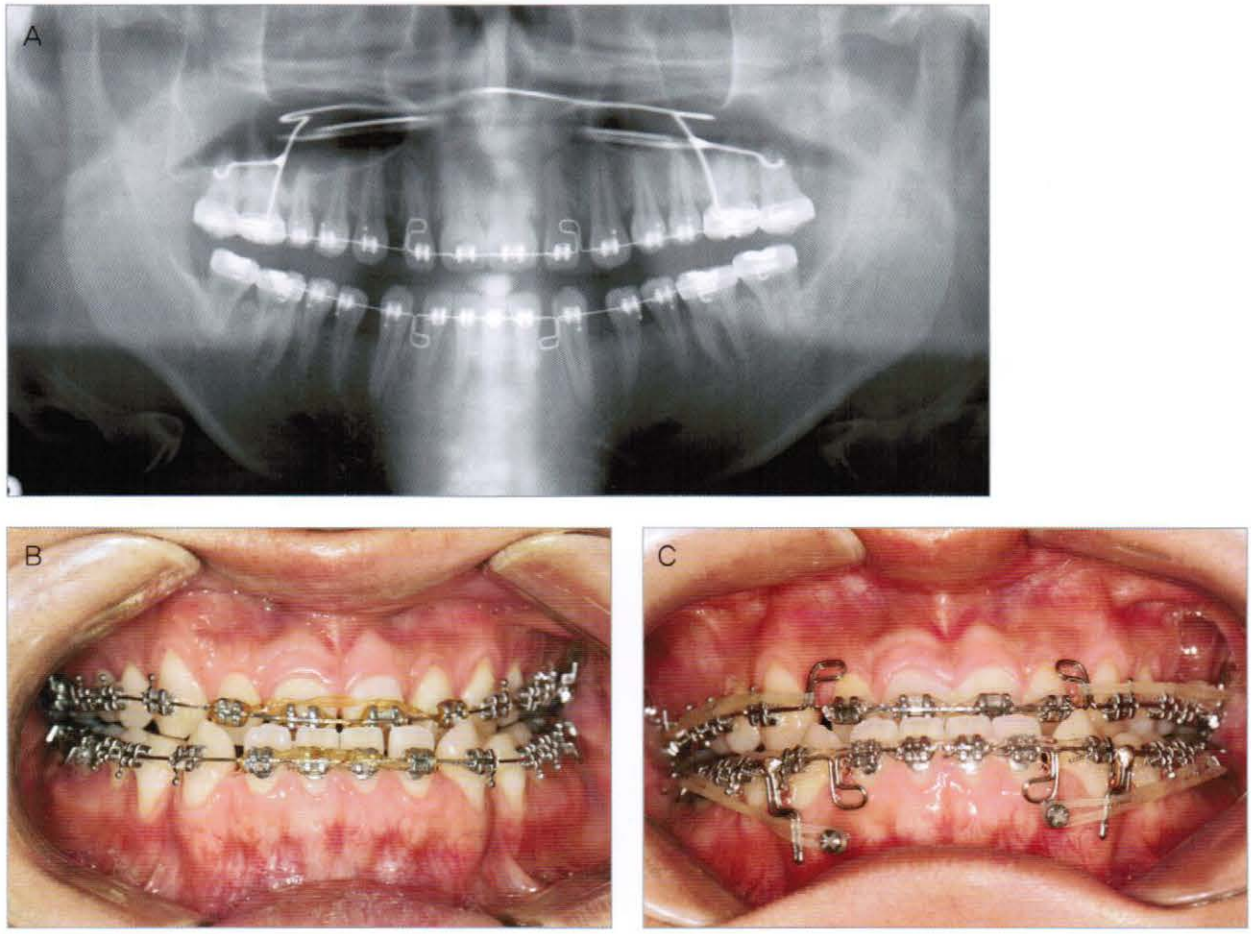

Figure 2-3-6. Case 5
A. Radiograph after leveling. The interradicular space between the lower lateral incisor and canine is fairly wide.
B. The gingival surface shows the concave area between the lateral incisor and canine.
C. Mini-implant in place. The mini-implant is used as anchorage for protraction of molars forward.

Ⅳ. Midpalatal suture area

Cortical bone in the midpalatal area is thick, with no dangerous anatomical structures, and oral hygiene maintenance is easy. These are good conditions for mini-implant insertion (Figure 2-4-1).

Implantation procedure

1. The soft tissue of the mid-palatal area on a line connecting the first molars is anesthetized.
2. The area is probed with an explorer. Even in adults, there are cases where the suture area has a deep depression. In these cases, the mini-implant should be inserted about 1mm to the side.
3. A long bur-type wrench is used in an endodontic contra-angle handpiece or implant engine, and a 1.6x6mm implant is inserted (Figure 2-4-2). A speed of 30rpm is used.
4. Place the mini-implant in the spot marked by the explorer, and make sure that the bottom of the handpiece is at least 6mm away from the upper incisal edge (Figure 2-3-3A). If the handpiece contacts the incisal edge, this will prevent insertion (Figure 2-4-3B). At least the length of the mini-implant should be left as working room.
5. When the collar portion of the mini-implant touches the soft tissues, stop the engine, and separate the bur-type wrench from the contra-angle handpiece.
6. The bur-type handpiece is then removed from the mini-implant head.
   When inserted in this way, the long axis of the mini-implant, rather than being perpendicular to the nasal floor, leans slightly distally (Figure 2-4-4). Refer to the study by Kang et al[7]. where the cortical bone thickness was measured on CT at this mini-implant angle (Figure 2-1-23).

If a Finger driver (111-120) is to be used (Figure 2-4-5), pilot drilling of the cortical bone is required. A short bur-type wrench (113-MJ-203) is used. To prevent accidental swallowing, floss must be threaded through the hole in the body of the Finger driver.

Clinical tip ››››

Points to remember for midpalatal insertion

- A short mini-implant is used.
- Insert as close to the center of the midpalate as possible. This prevents perforation into the nasal cavity. At times, mini-implant insertion 5mm away from the midpalatal suture is seen. In these areas, there is high risk of perforation into the nasal cavity.
- In growing children and in certain cases even in adults, union of the midpalatal suture is yet to occur. The mini-implant should be inserted around 1mm to the side.
- When using the implant engine, high resistance is felt when penetrating the cortical bone. Insert slowly while cooling with saline irrigation.

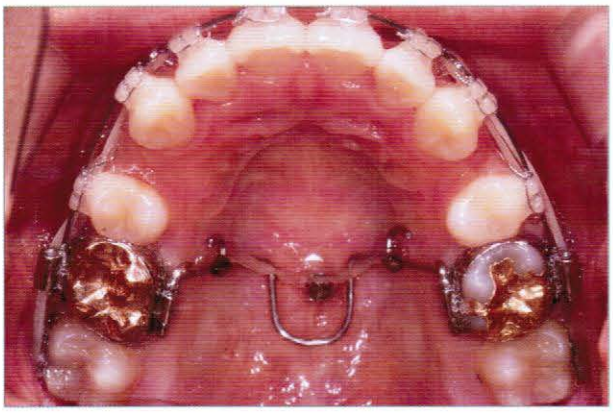

Figure 2-4-1. Mini-implant in the midpalatal region
Inserted at the center of a line connecting the first molars. This is a safe area for implantation.

Figure 2-4-2. Long bur-type wrench (113-MD-204), contra-angle handpiece and 1.6×6mm mini-implant in place.

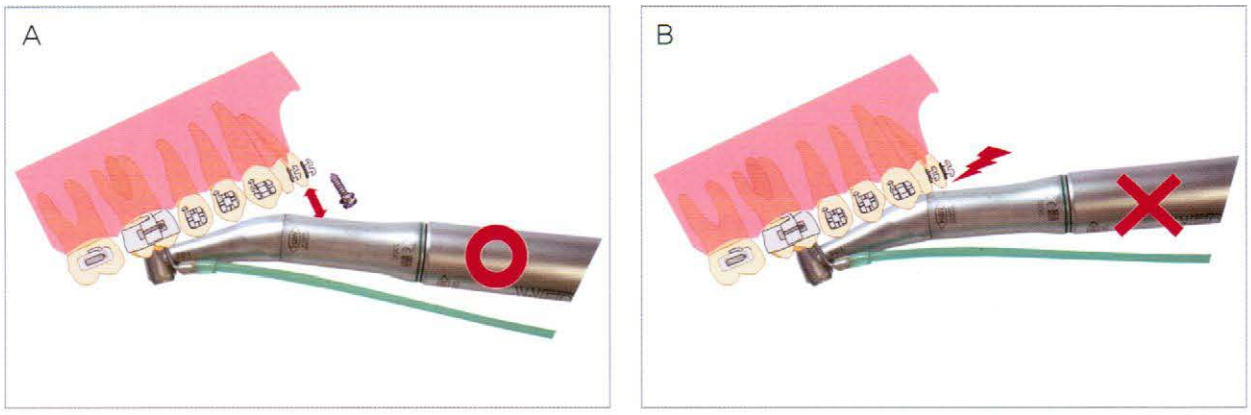

Figure 2-4-3. Points to remember prior to insertion
A. Place the mini-implant tip at the point marked by the explorer, and make sure that there is at least 6mm of spare room between the handpiece and upper incisal edge.
B. If contact is made between the handpiece and upper incisal edge, insertion is prevented.

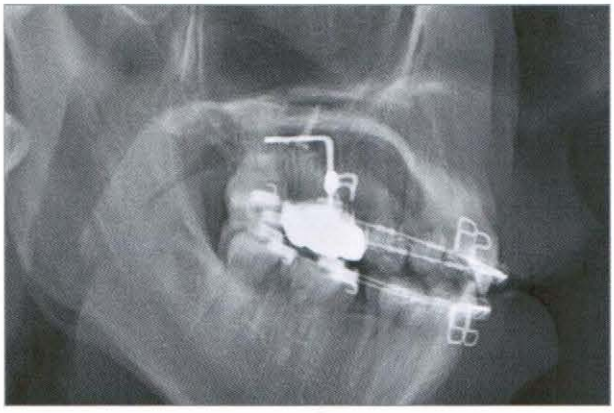

Figure 2-4-4. A 1.6×6mm mini-implant inserted in the midpalatal suture area
Rather than being perpendicular to the nasal floor, the mini-implant head is leaning slightly distally.

Figure 2-4-5. Finger driver (111-120), short bur-type wrench (113-MJ-203) and 1.6×6mm mini-implant in place
Long floss silk is threaded into the body of the finger driver.

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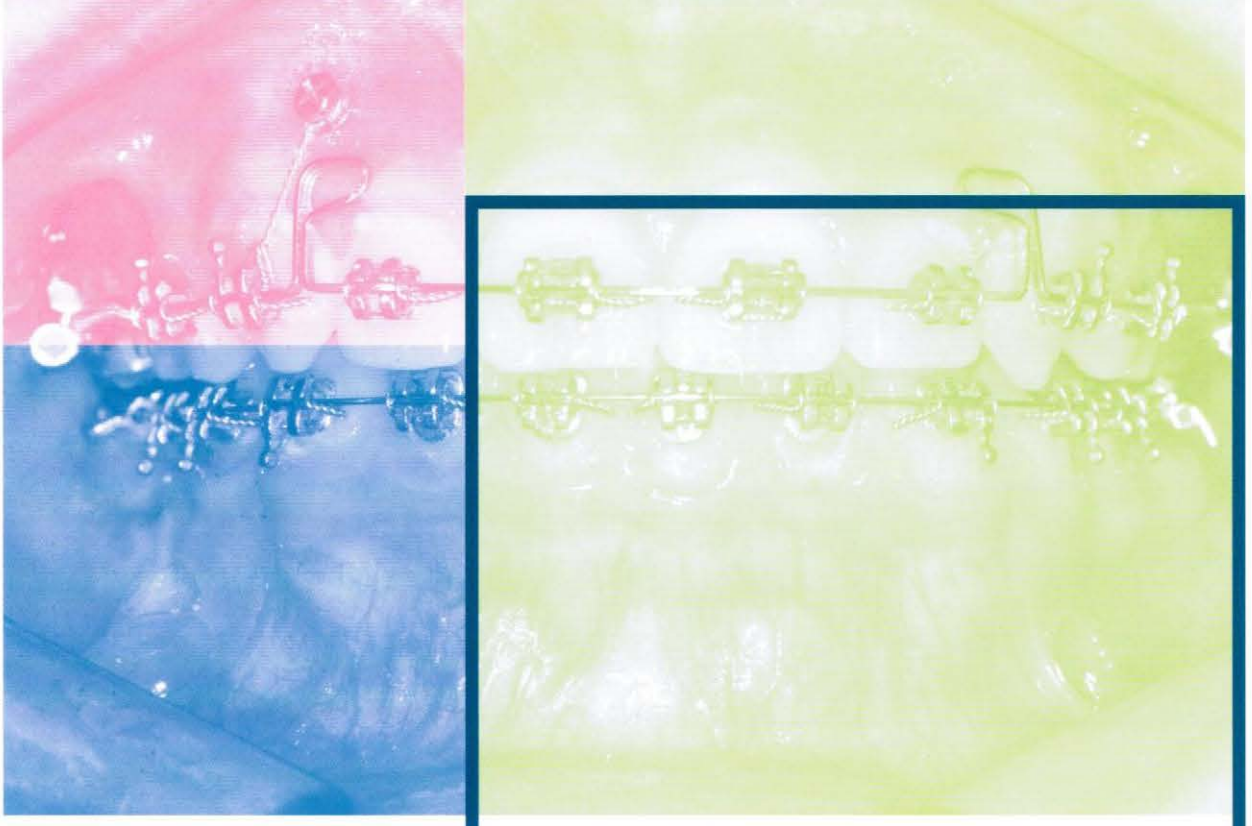


Chapter 3

Reinforcement of posterior anchorage

Chapter 3 Reinforcement of Posterior Anchorage

Cases where posterior anchorage should be reinforced include mouth protrusion, upper anterior protrusion, and severe crowding. Sequential treatment is described using actual cases.

I . Mouth protrusion

In Class I mouth protrusion with severe upper and lower incisor labioversion, 4 first premolar extractions with mini-implants used as anchorage shortens the treatment time needed with traditional methods. In addition, with mini-implant use, it is easier to place lingual root torque on the upper incisors as the upper molar anchor is reinforced.

■ Case 1 (Figure 3-1-1 to 31)

- Age : 20 years 2 months
- Sex : female
- Chief complaint : mouth protrusion, gummy smile

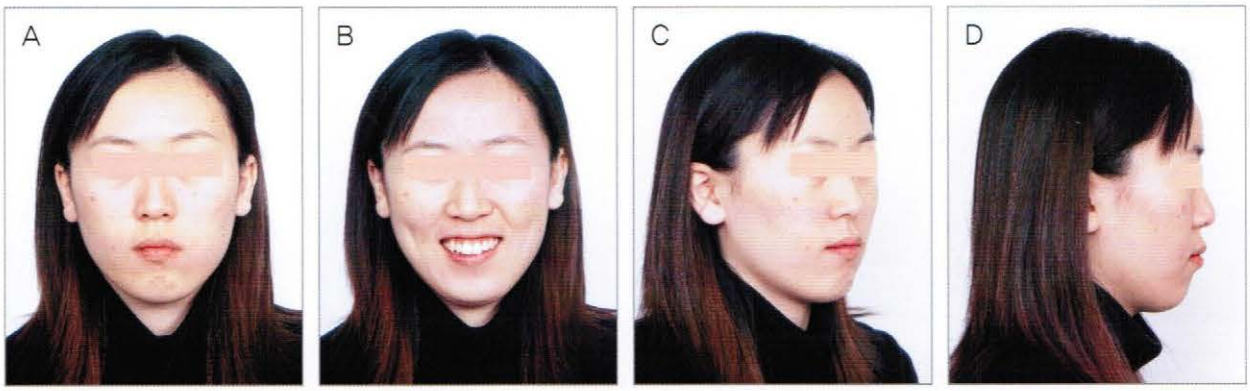
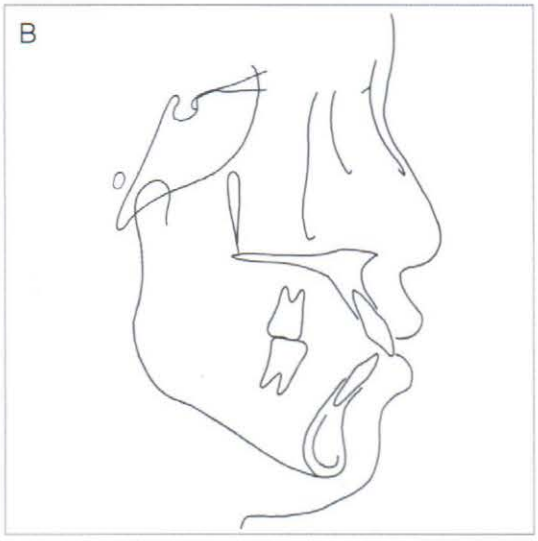


Figure 3-1-1. Pre-treatment facial photograph of Case 1
She shows mouth protrusion and difficulty with keeping the mouth closed. The muscles around the mouth must be tensed to keep the mouth closed.
A. She shows contraction of the mentalis muscle during mouth closure.
B. Gummy smile.
C, D. Mouth protrusion, small nasolabial angle, and retrusive chin.

Figure 3-1-2. Pre-treatment intraoral photograph of Case 1
The upper and lower dentition shows slight crowding and open bite (A, F, G). The lower midline is deviated slightly to the left. The patient's left canine and first molar shows a Class II tendency (D).



C

	Norm	SD	T1
SNA	81.6	3.2	79.1
SNB	79.2	3.0	77.0
ANB	2.5	1.8	2.1
FMA	24.3	4.6	25.7
U1 to FH	116.0	5.8	120.6
IMPA	95.9	6.4	100.6
IIA	123.8	8.3	113.1
Esth-U	-0.9	2.2	1.3
Esth-L	0.6	2.3	3.7

Figure 3-1-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. Showing slight open bite and lip incompetency.
B, C. Antero-posterior skeletal relationship can be called Class I. Although anterior teeth show open bite, the vertical skeletal pattern is closer to normal (ODI = 69.0). Upper and lower incisors show labioversion. U1 to FH is 120.6°, and IMPA 100.6°. The interincisal angle (113.1°) is smaller than the norm.

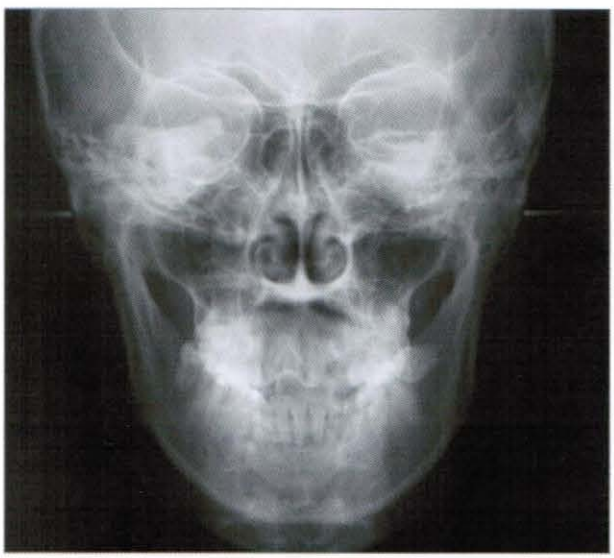


Figure 3-1-4. Postero-anterior radiograph
Shows no asymmetry.

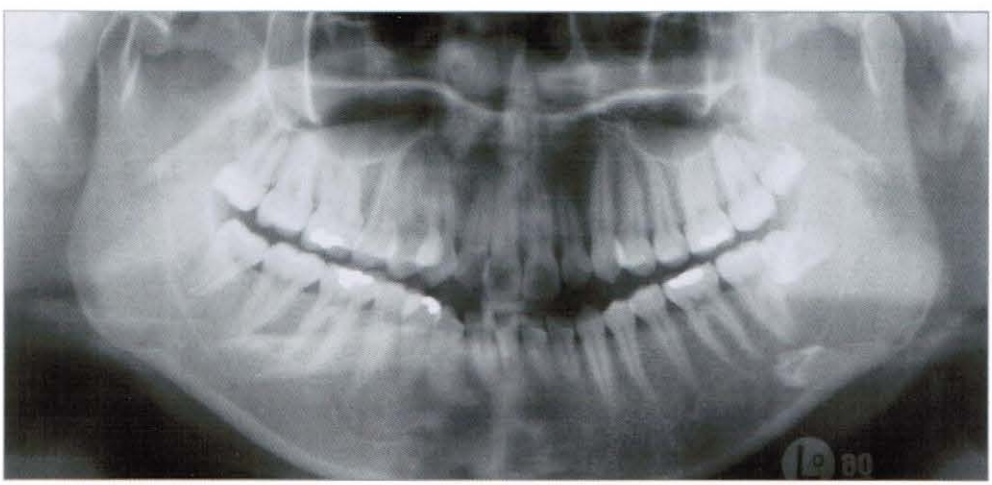


Figure 3-1-5. Pre-treatment panoramic radiograph
All the third molars are present, and the lower left third molar shows horizontal impaction.

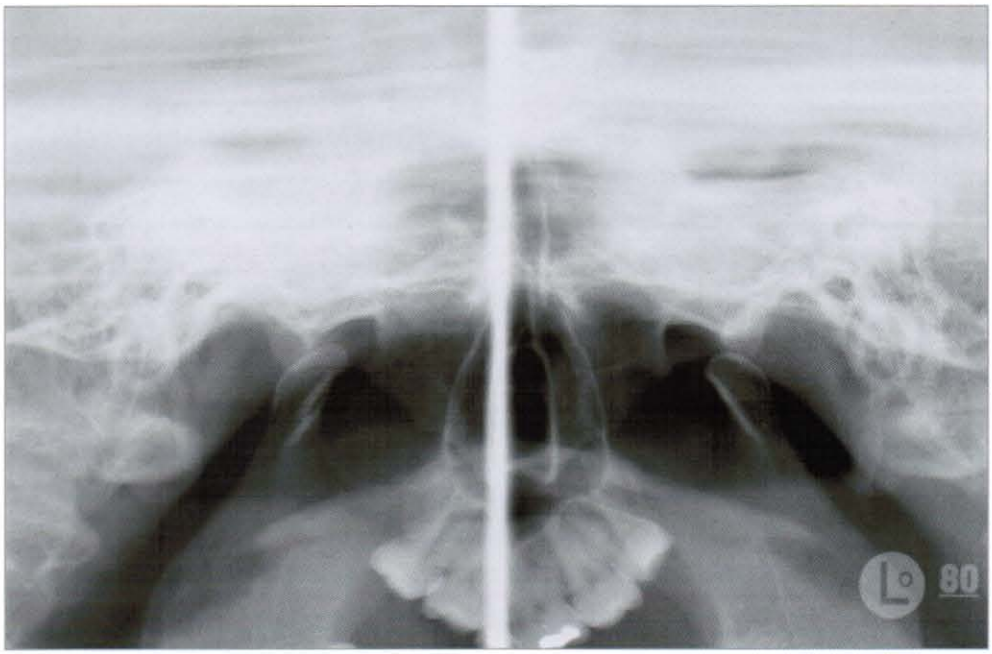


Figure 3-1-6. Pre-treatment TMJ panoramic radiograph
No abnormal features of the mandibular condyle.

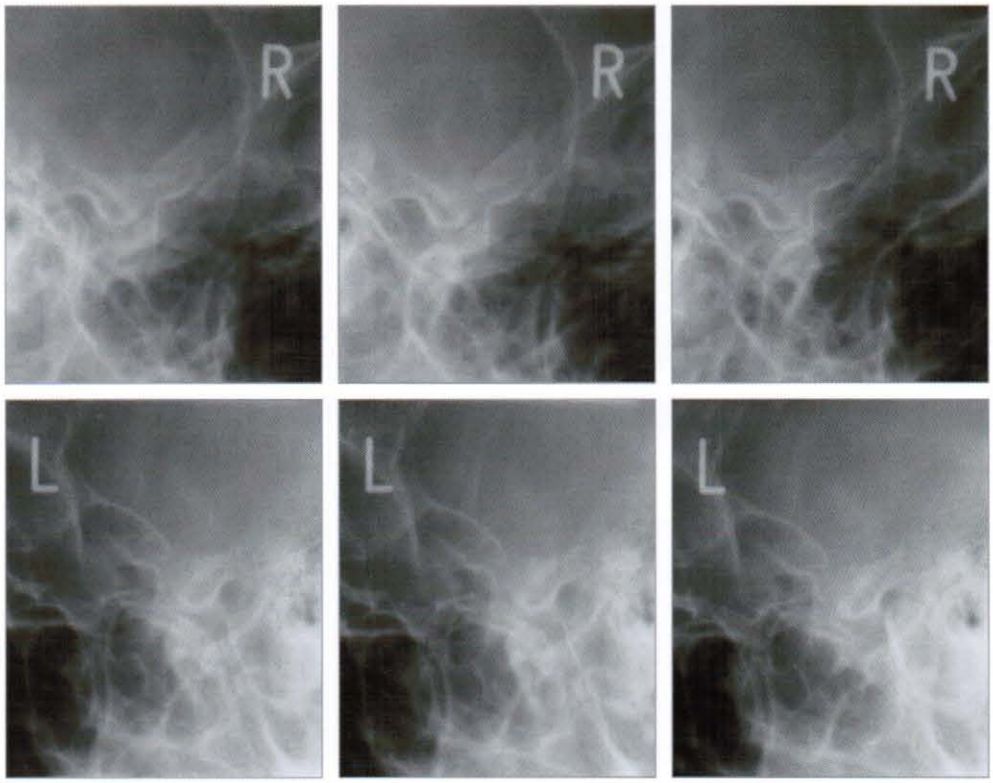


Figure 3-1-7.
Transcranial radiograph
No abnormal features shown.

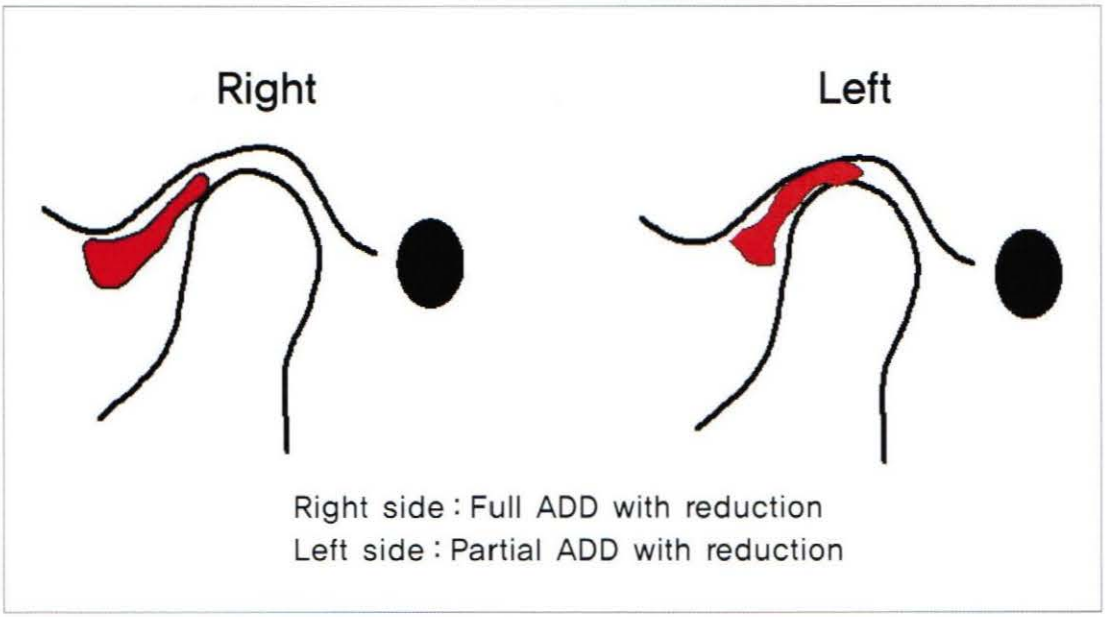


Figure 3-1-8. MRI during mouth closing
The right joint showed full anterior disk displacement (ADD) with reduction and the left joint showed partial ADD with reduction.

Clinical tip ››››

For patients with open bite tendency (especially Class II) the TMJ needs to be assessed carefully during diagnosis.

Clinical signs and symptoms and past history should be checked, and radiographs (such as panoramic radiograph, TMJ panoramic radiograph, transcranial view, CT) should be investigated for changes in the shape of the condyle (such as flattening, beaking, resorption, cyst, sclerosis). MRI can be used to check for displacement of the disk or joint effusion. In Class II open bite patients, at least 60~70% have displacement of the disk.

References

- Sug-Joon Ahn, Tae-Woo Kim, Dong-Seok Nahm. Cephalometric keys to internal derangement of temporo-mandibular joint in women with Class II malocclusions, Am J Orthod Dentofac Orthop 2004:126:486-95.
- Hoon Jung, Tae-Woo Kim et al. Treatment of Temporomandibular Joint Disorder : Clinical cases, 16-38, Narae, 2008.
- Tae-Woo Kim, Eun-Sun Byun, Young-Il Chang, Dong-Seok Nahm, Won-Sik Yang. MRI Study of Temporomandibular Disorders in Orthodontic Patients, Korean J Orthod: 30:234-244, 2000.

Treatment Progress

■ **Leveling** — 4 months
- 2002. 8.2 — 014″ NiTi
- 2002. 9.6 — 016″ NiTi
- 2002. 10.4 — 016×022″ NiTi

■ **Implantation**
- 2002. 12.5 — 1.6×6.0 2 EA 6|5|5|6

■ **Space closing** — 7 months
- 2002. 12.10
  - U : 019×025″ ss with long hooks
  - L : 018×022″ ss with shoe hooks
    - NiTi closed coil spring
    - Stripping on lower incisors

■ **Detailing** — 8 months
- 2003. 7.8 U : 019×025″ ss with shoe hooks (crown labial torque)

■ **Debonding**
- 2004. 3.19

Total 19 months

The patient in Case 1 has a Class I (slightly Class II on the left side) open bite. This is an ideal case to be treated with four first premolar and four third molar extractions. 022″ slot MBT (3M-Unitek) brackets were used. Leveling took 4 months. A periapical radiograph was then taken (Figure 3-1-11). A 6mm length, 1.6mm diameter mini-implant was inserted between the upper second premolar and first molar. Closure of extraction spaces took 7 months. Using the traditional method, the upper canine is retracted first, and the 4 upper incisors are then retracted. Retraction usually took more than 12 months. This time has been markedly decreased using mini-implants. However because there is no movement of the posterior molars, closure of the extraction space occurs entirely through retraction of incisors, and takes at least 7 months. The detailing phase took around 8 months. At this stage, to compensate for linguoversion of upper incisors, crown labial torque was given. Total treatment time was 19 months.

Clinical tip ››››

Except for special cases, mini-implants are inserted after leveling up to 016x022″ NiTi. This is because if there is crowding present, the roots may make contact with the mini-implant during tooth movement. Also, after leveling, periapical radiograph will show that the regular pattern of root arrangement and distance will help avoid root contact.

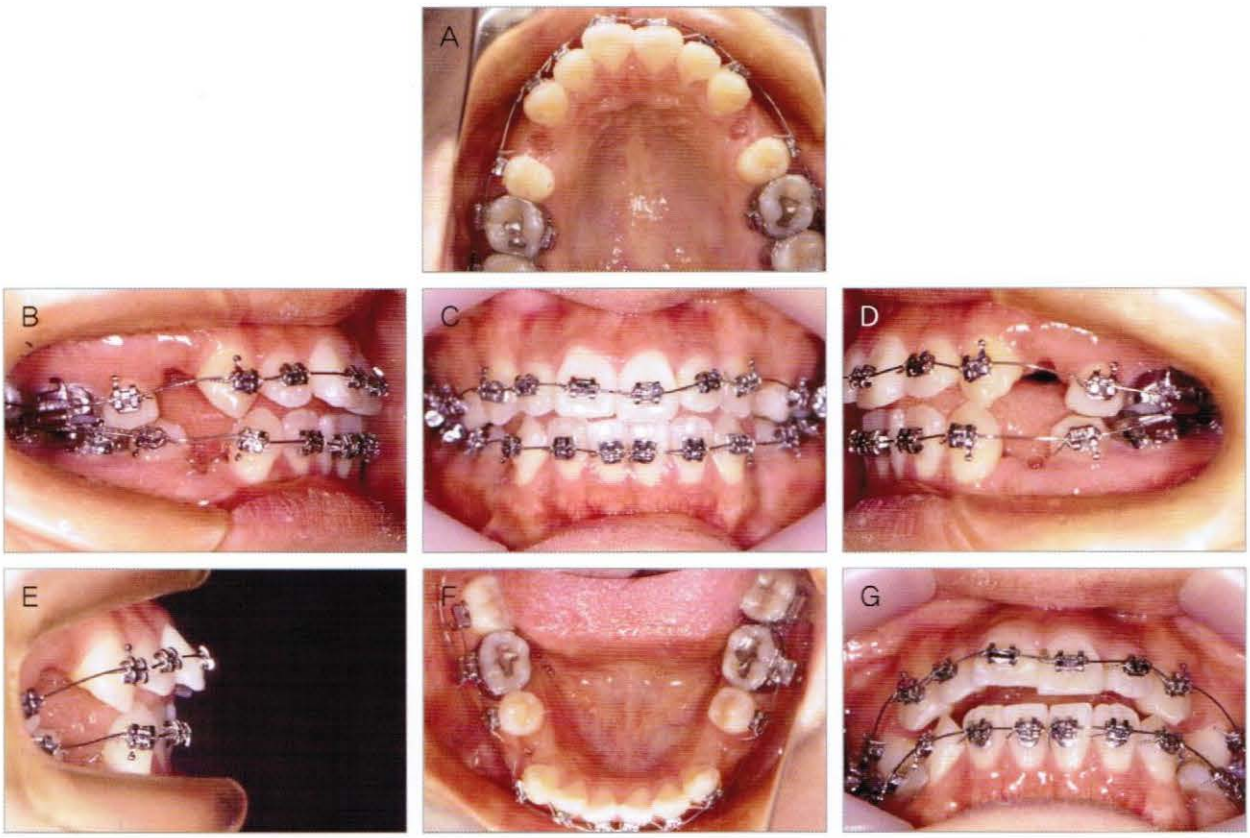


Figure 3-1-9. Leveling stage (2002.8.2)
Photograph taken after ligation of 014" NiTi wire

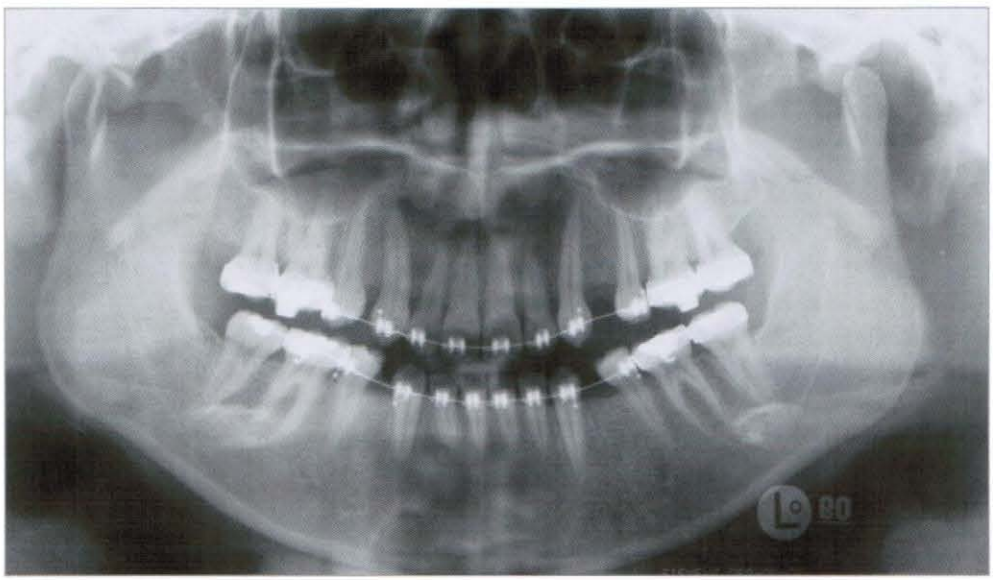


Figure 3-1-10. Panoramic radiograph taken after leveling up to 016×022" NiTi (2002.11.5)

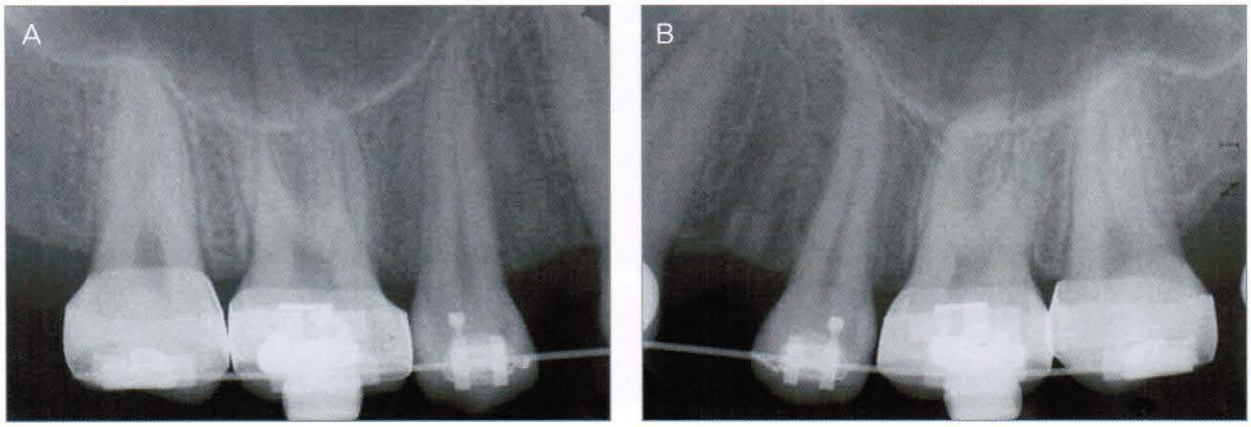


Figure 3-1-11. Periapical radiograph taken after leveling up to 016×022" NiTi (2002.11.5)
The interradicular distance between the right second premolar and first molar is fairly wide, but the right side is narrow. The mini-implant was inserted without a guide wire as this was before Kim's stent was invented.

Clinical tip ››››

To recommend a radiograph to take prior to mini-implant insertion, the periapical radiograph is suggested.

On panoramic radiograph (Figure 3-1-10), the second premolar and first molar are overlapped, and the interradicular distance is difficult to ascertain. However, on periapical radiograph (Figure 3-1-11) the roots are not overlapped and an accurate assessment of the interradicular distance is possible. Rather than taking a CT which has lower resolution, higher radiation and cost, a periapical radiograph is a better option.

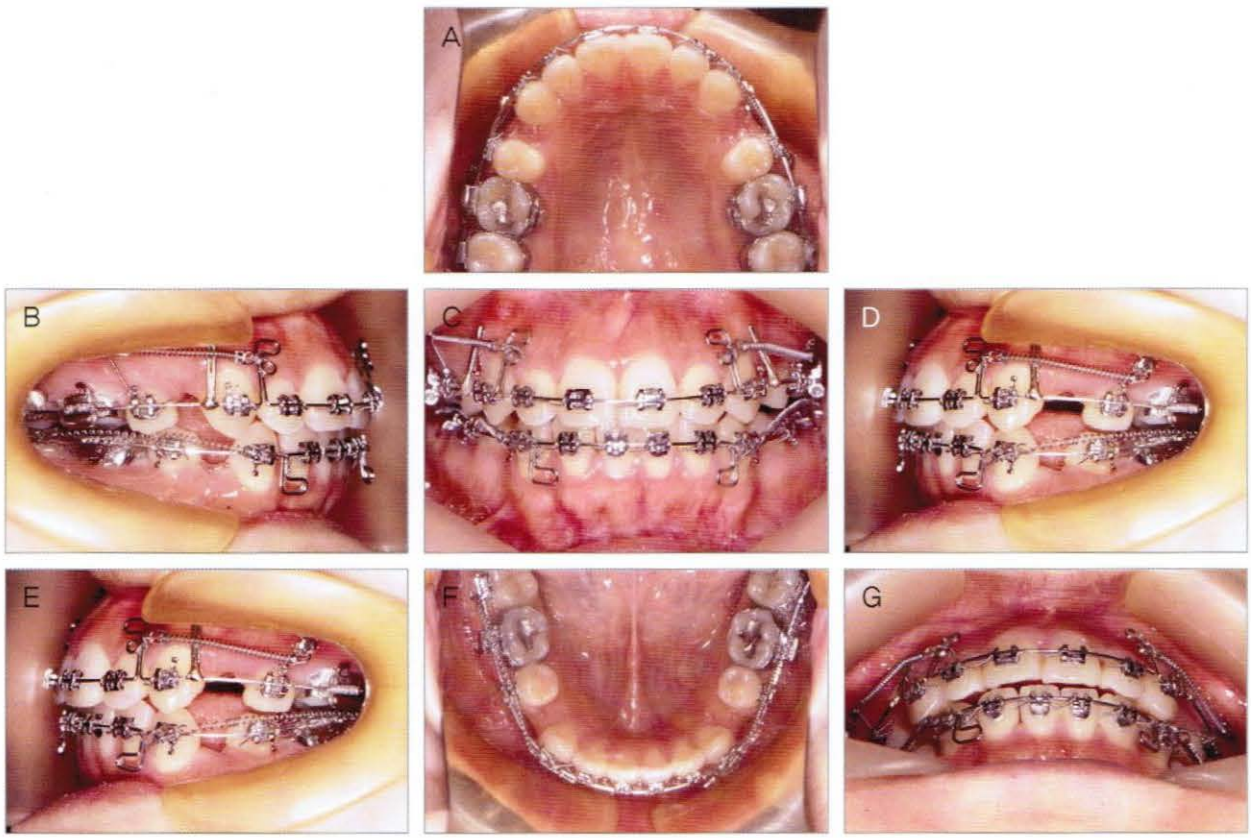
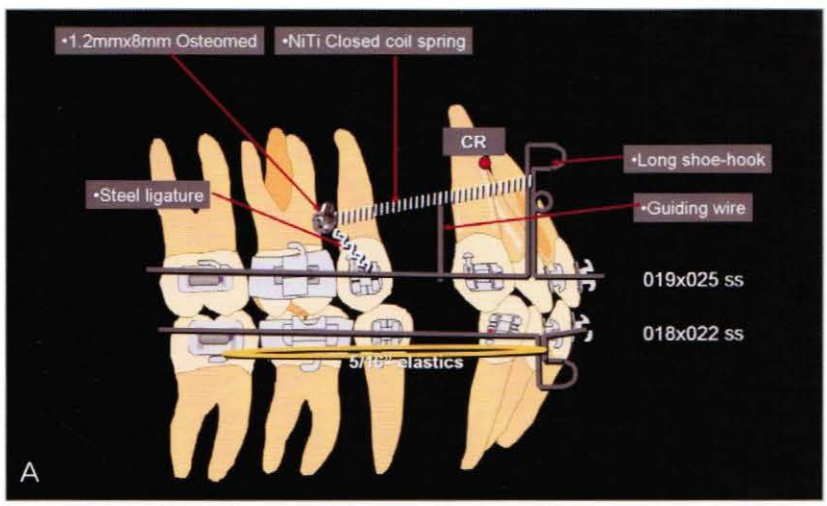


Figure 3-1-12. Space closure stage (2002.12.10)
Space closure using sliding mechanics with upper 019×025" ss and lower 018×022" ss wires.



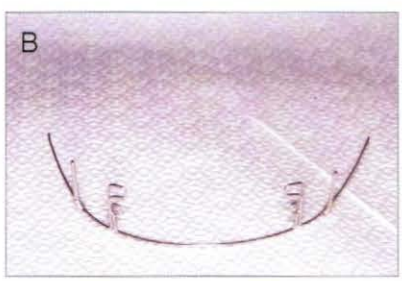


Figure 3-1-13. Mechanics of space closure
A. Diagram of space closure mechanics
B. Upper 019×025" ss wire
C, D. Instead of bending shoe hooks on the upper wire, ready-made products can be used.

Clinical tip ››››

Mechanics of space closure (Figure 3-1-13A)

For reinforcement of anchorage during upper incisor retraction, 1.6x6mm mini-implants are inserted between the second premolar and first molar. The implant head and second premolar are securely ligated using ligature wire. This ligature wire prevents the posterior teeth from being pushed forward, and also prevents the anterior teeth from being extruded during the retraction phase. Long shoe hooks were made using 019x025" ss wire. The pulling force should be placed as close to the center of the upper incisors as possible to prevent incisor linguoversion during retraction. The circle loop below the L-loop prevents the NiTi coil spring from slipping down. Use of NiTi closed coil spring also means that longer appointments can be planned. A bent 0.7mm ss wire has been soldered behind the upper canine to prevent the coil spring from impinging on the gingiva.

Conventional retraction methods were used in the lower arch as the posterior molars usually provide enough anchorage. Shoe hooks were made between the lateral incisor and canine using 018x022" ss wire. 5/16" 6 oz Class I elastics are used. If patient compliance is poor, NiTi closed coil spring can be used in the lower arch also.

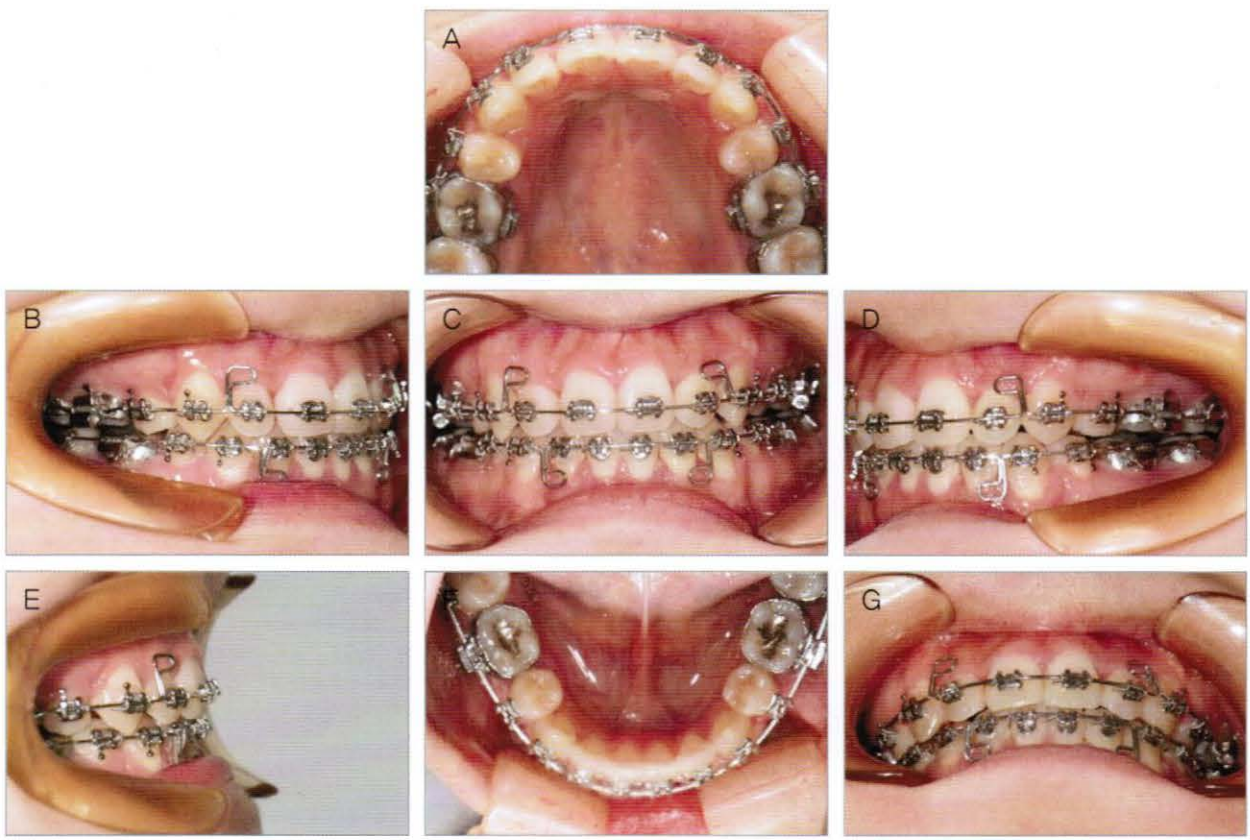


Figure 3-1-14. Detailing stage (2003.10.2)

Space closure was finished 13 months after start of treatment, and the occlusion is now being detailed. The long shoe hook of the upper arch has been changed to a short shoe hook using 019×025" ss wire. Curvature has been given to the upper arch to compensate for the linguoversion of the incisors which occurred during the space closing stage. Wire bending between the brackets will allow for better interdigitation, and corrects the steps present between the marginal ridges. Left molars are still slightly open (D). Panoramic radiograph (Figure 3-1-16) is taken at this stage to check for root resorption, and root parallelism. This is taken into consideration at the detailing stage to obtain a more perfect result. Usually up-and-down elastics using 3/16" 6 oz are placed between the upper and lower shoe hooks to prevent bite opening and for interdigitation of the molars.

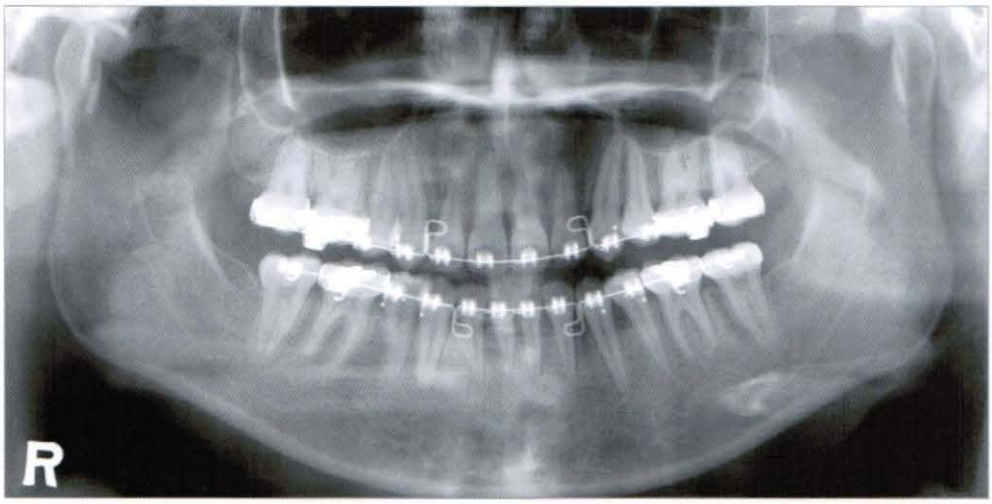


Figure 3-1-15. After space closing and before the detailing stage, a panoramic radiograph (and cephalometric radiograph if needed) is taken to plan how detailing is to be carried out. In this case, there is no root resorption and root parallelism is good. The canine roots have been overcorrected distally and sits close to the second premolar roots.

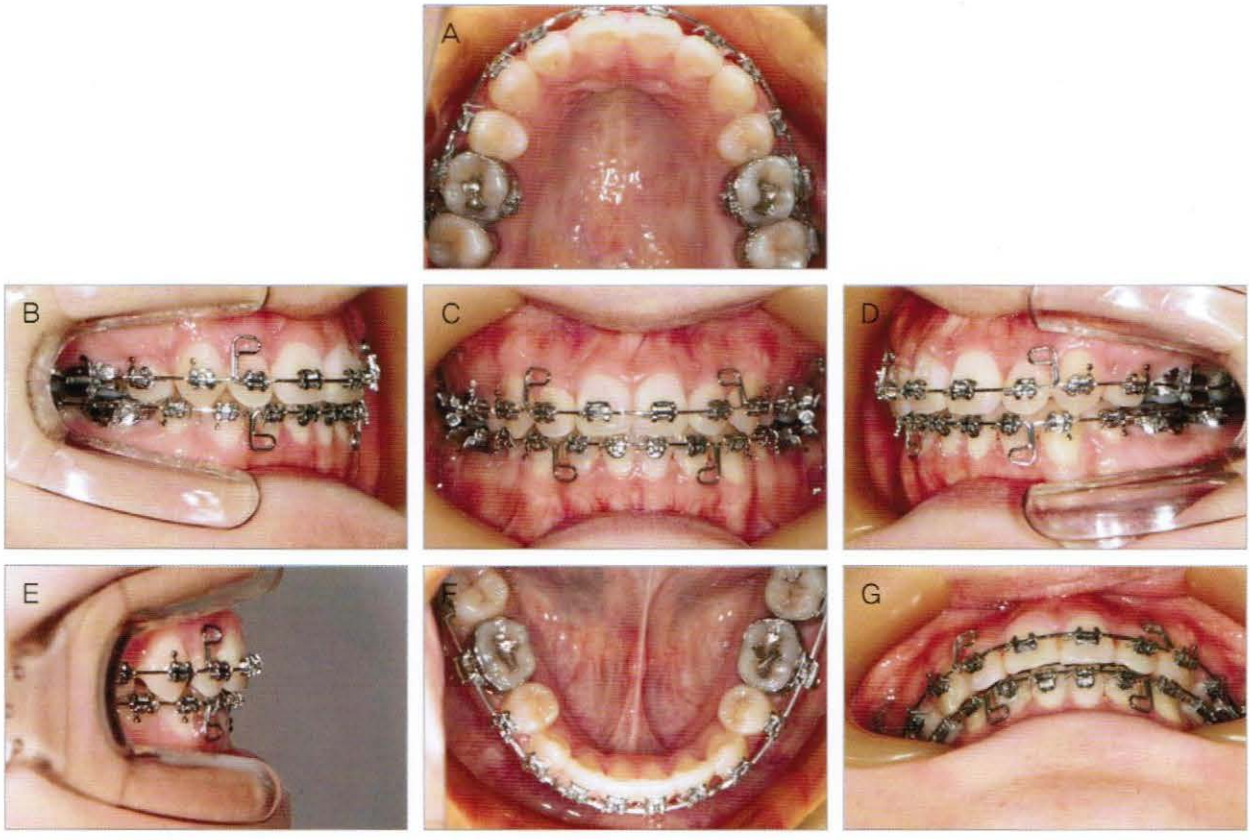


Figure 3-1-16. Results of detailing (2003.12.18)
There is better interdigitation of the left molars 16 months into treatment (D).

Clinical tip ››››

How to close band spaces

After removal of the first molar bands, patients complain at times of food impaction in the band spaces. During the detailing stage, upper first molar bands can be removed and Class I elastics used for around 3 weeks. This will help close the band spaces which may occur between the second premolar and first molar and between the first and second molars. The rest of the brackets are removed after checking that all the band spaces have been closed.

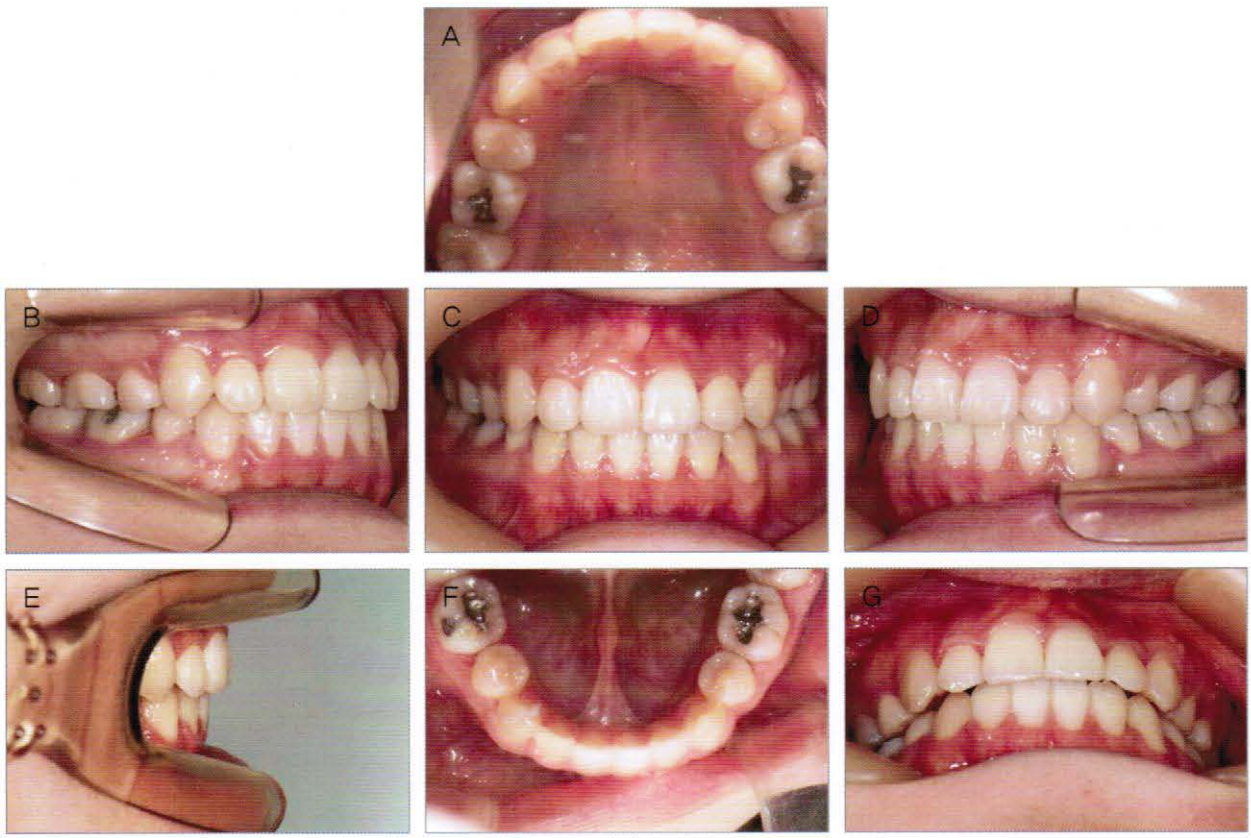


Figure 3-1-17. Intraoral photographs at debonding (2004.3.19)
Treatment was finished 19 months after beginning of treatment.

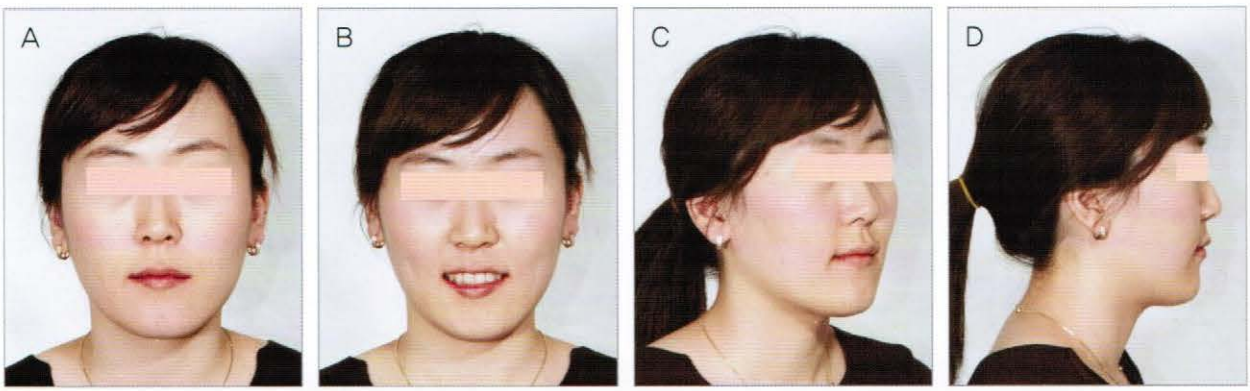
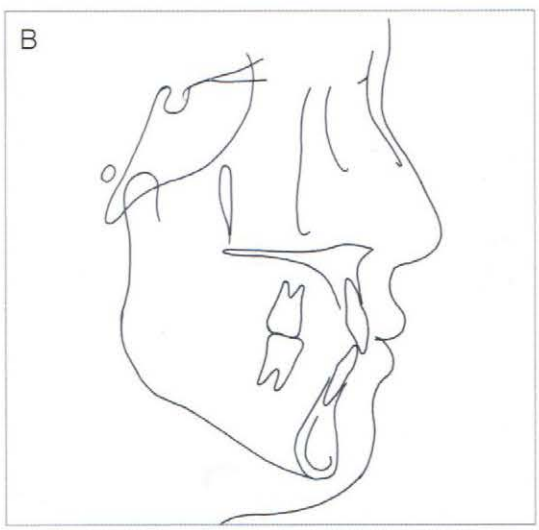
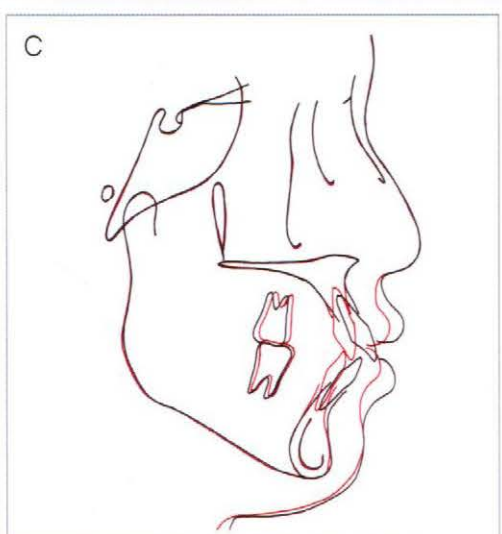


Figure 3-1-18. Facial photographs at debonding (2004.3.19)
A. Muscle strain around the mouth during lip closing has disappeared. Wrinkling due to mentalis muscle strain has also disappeared.
B. Gummy smile has improved.
C, D. Mouth protrusion has been treated and she shows good facial proportions. The small nasolabial angle has normalized. With improvements in mouth protrusion, the nose looks relatively higher.





D

	Norm	SD	T1	T2
SNA	81.6	3.2	79.1	80.0
SNB	79.2	3.0	77.0	76.6
ANB	2.5	1.8	2.1	3.4
FMA	24.3	4.6	25.7	26.0
U1 to FH	116.0	5.8	120.6	103.4
IMPA	95.9	6.4	100.6	88.1
IIA	123.8	8.3	113.1	142.6
Esth-U	−0.9	2.2	1.3	−2.4
Esth-L	0.6	2.3	3.7	−1.5

Figure 3-1-19. Cephalometric measurement after debonding
A. On cephalometric radiograph, lip incompetency has disappeared. Anterior open bite has been treated.
B. Cephalometric tracing at debonding.
C, D. Superimposition of pre- and post-treatment. There has been slight mesial movement of first molars, but no extrusion. The upper and lower incisors have been retracted a fair amount.

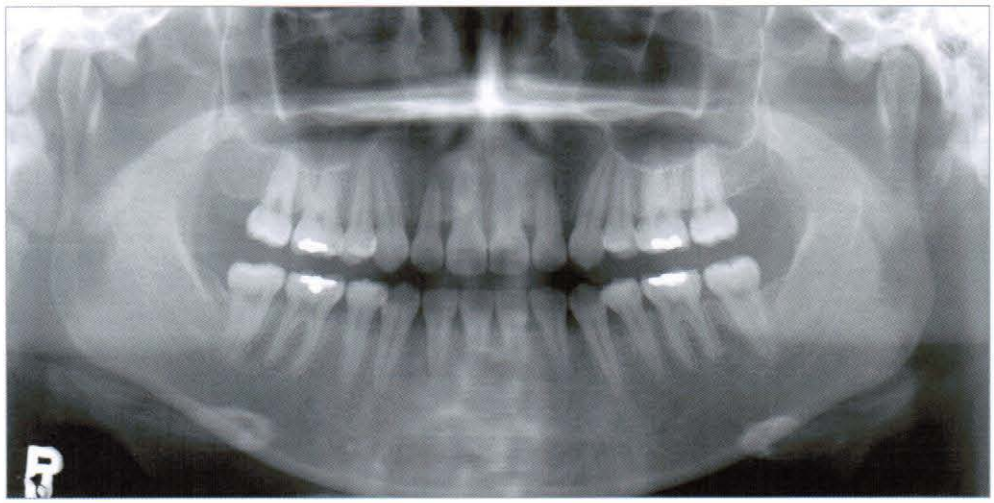


Figure 3-1-20. Panoramic radiograph at debonding

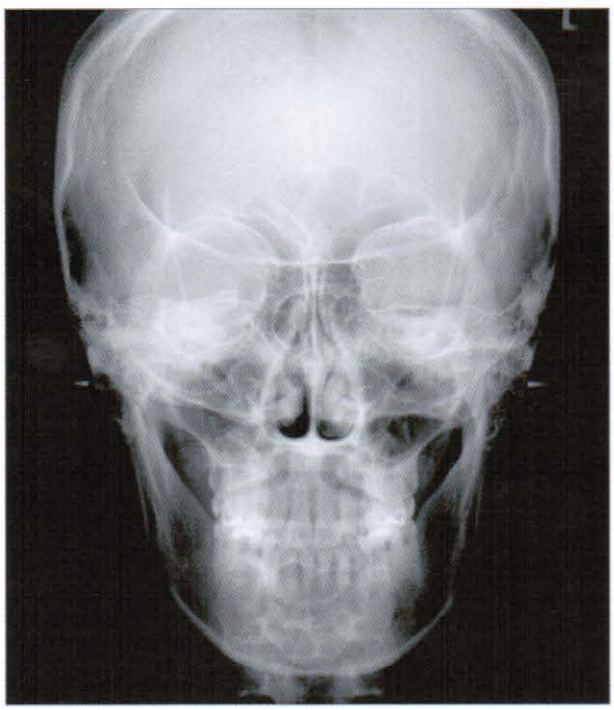


Figure 3-1-21. Postero-anterior radiograph at debonding

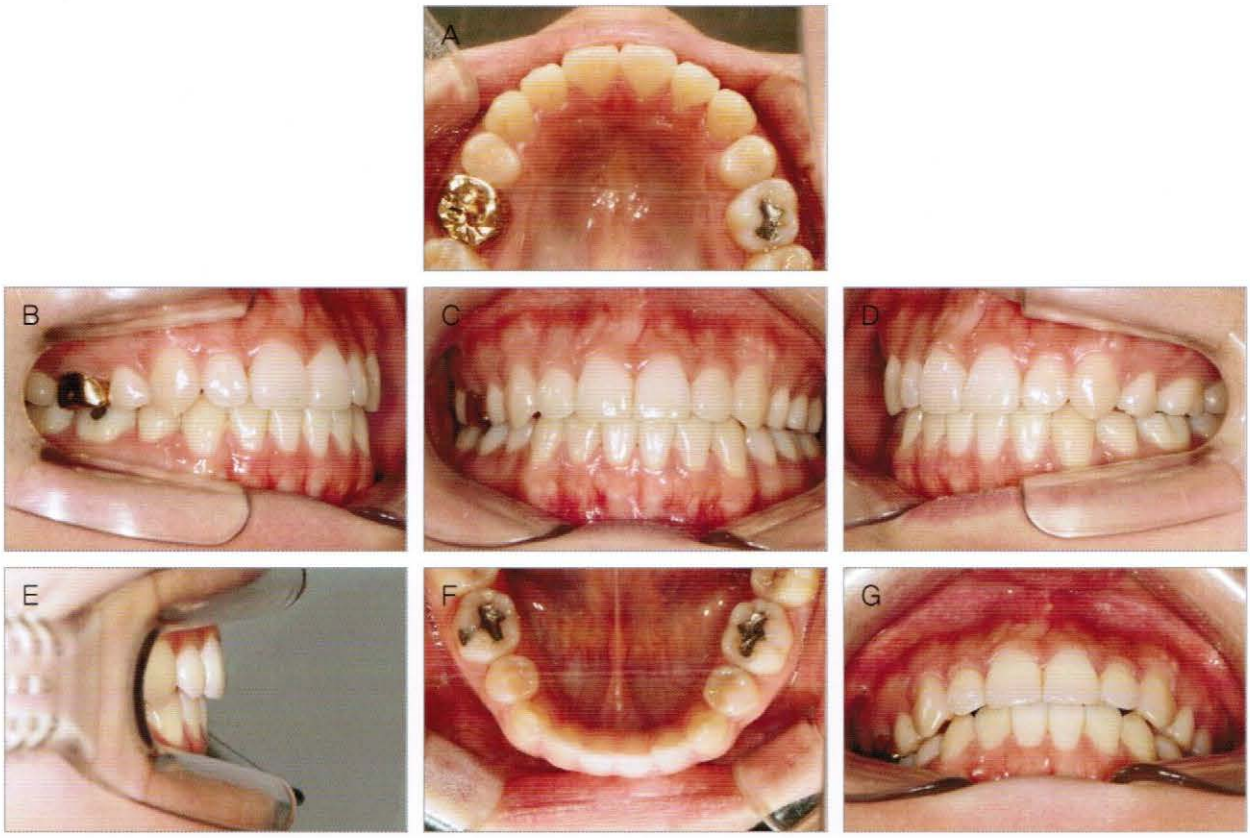


Figure 3-1-22. Intraoral photographs at 11 months post-retention (2005.2.4)
Good occlusion is being maintained.

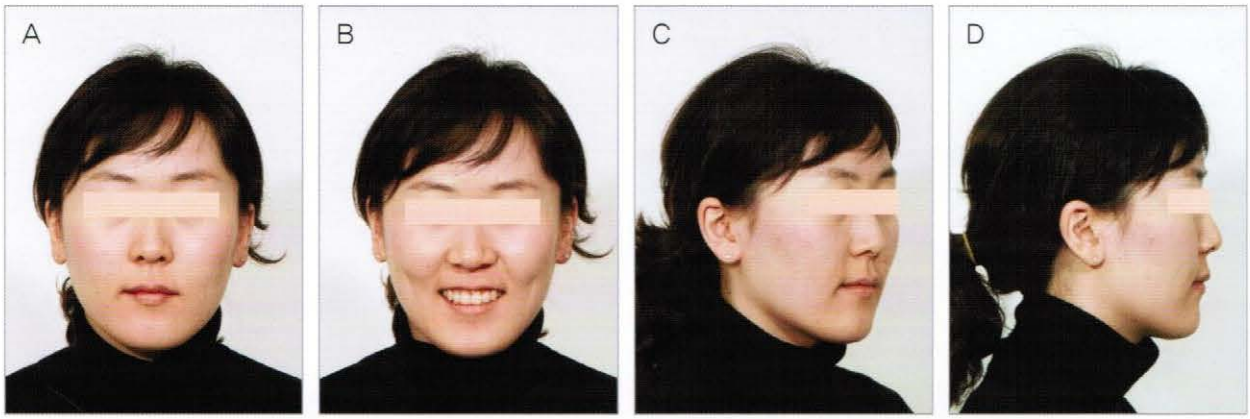


Figure 3-1-23. Facial photographs at 11 months post-retention (2005.2.4)

Figure 3-1-24. Cephalometric radiograph at 11 months post-retention (2005.2.4)

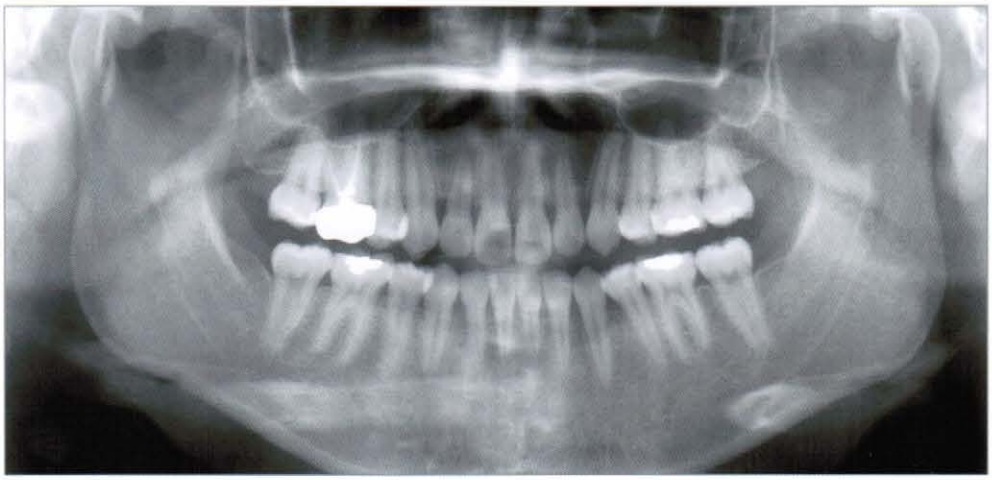


Figure 3-1-25. Panoramic radiograph at 11 months post-retention (2005.2.4)

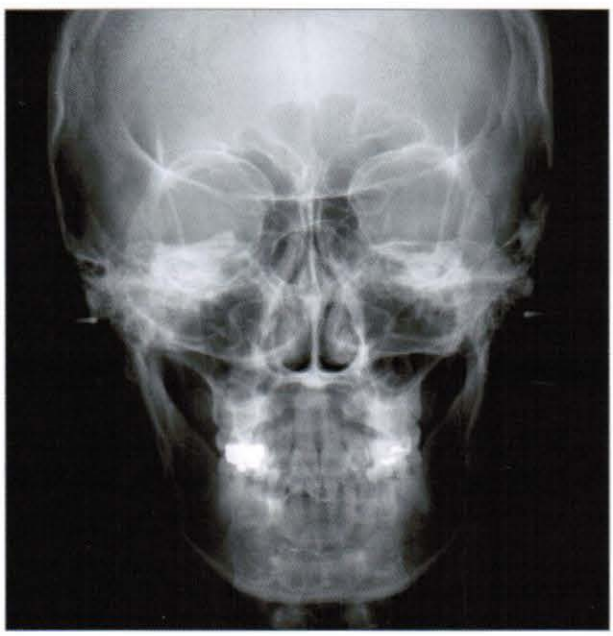
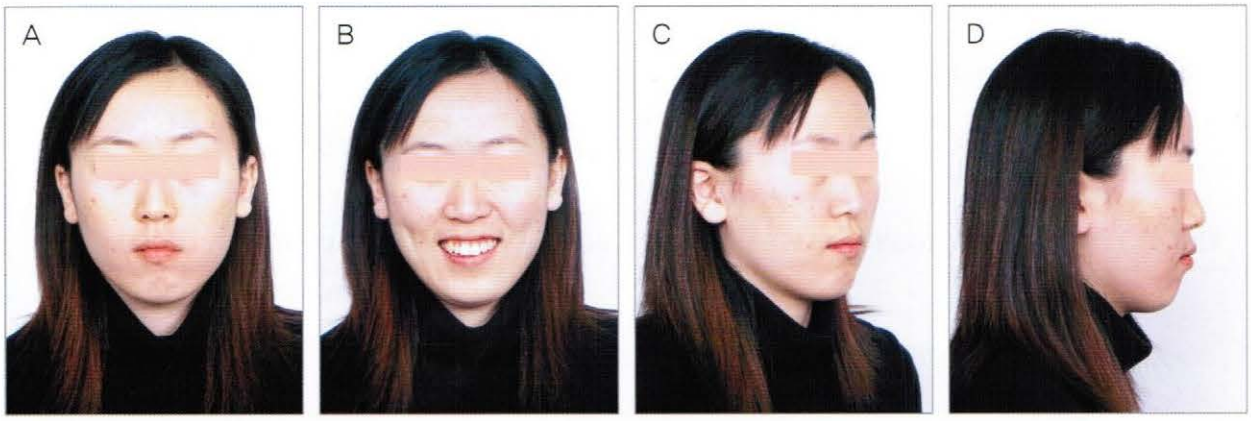


Figure 3-1-26. Postero-anterior radiograph at 11 months post-retention (2005.2.4)

Pre-treatment



Post-retention

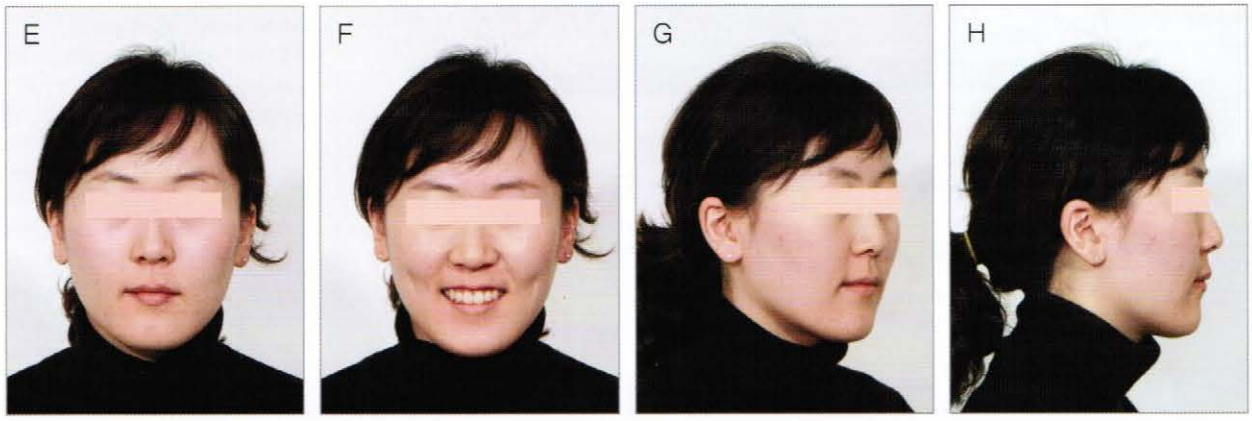


Figure 3-1-27. Comparison of pre-treatment (A-D) and post-retention (E-H) facial photographs.

Improvement of gummy smile

Comparison of photographs B and F in Figure 3-1-27 show that gummy smile has improved. Using the mechanics shown in Case 1 will improve gummy smile, and the process is described below.

〈Process 1〉 Tightly ligate the mini-implant and upper second premolar bracket

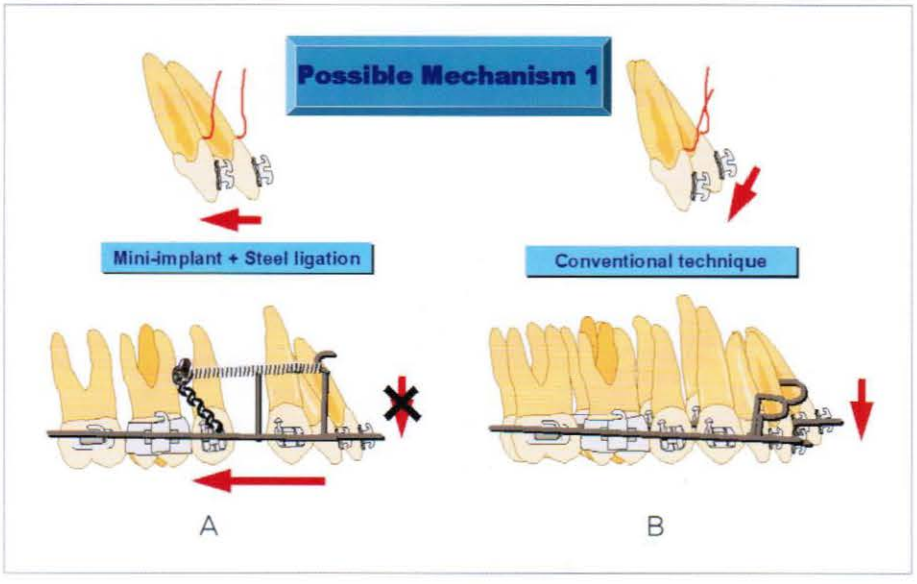


Figure 3-1-28. First process for gummy smile improvement
A. When using mini-implants for retraction of incisors, tightly ligating the mini-implant with the second premolar bracket will prevent the incisors from extruding during retraction.
B. During conventional retraction without the use of mini-implants, the gingiva extrudes together with the upper incisors and the gummy smile is worsened.

〈Process 2〉 Use of compensating curve

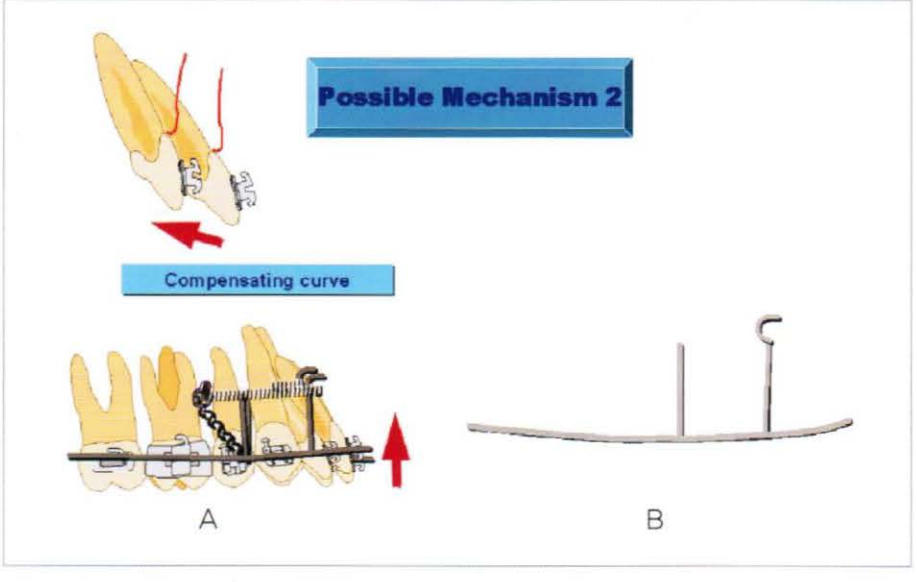


Figure 3-1-29. Second process for gummy smile improvement
With the mini-implant and second premolar bracket tightly ligated (A), compensating curve (B) is given to the upper wire, which causes the upper incisors to intrude.

〈Process 3〉 Descent of upper lip

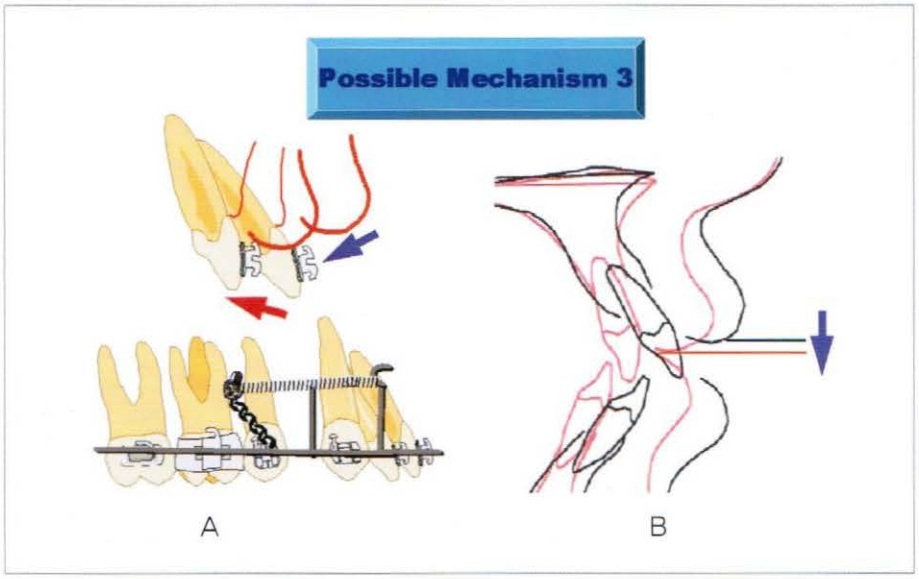


Figure 3-1-30. Third process for gummy smile improvement
As the upper incisors are retracted back, the upper lip drops down and back. Exposure of the upper incisors and gingiva is decreased.

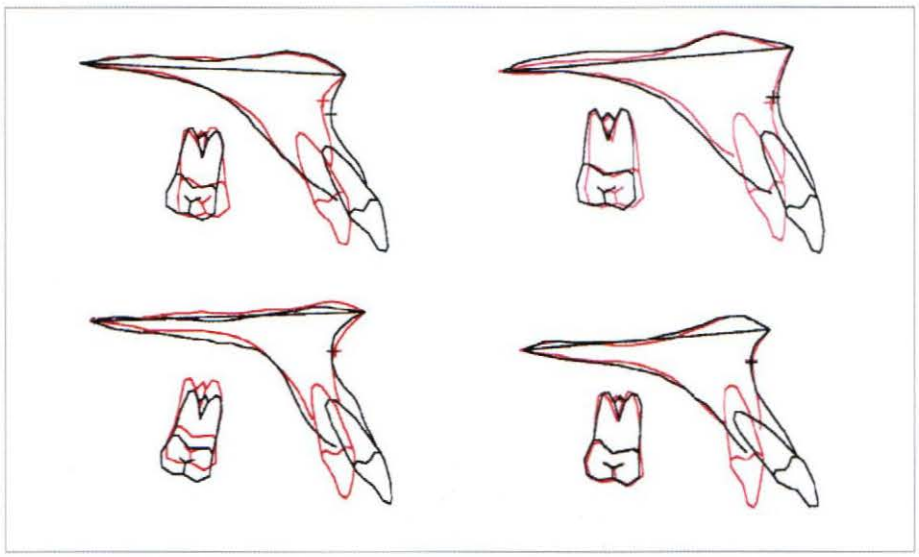


Figure 3-1-31. Mouth protrusion cases treated with similar mechanics used in Case 1. Various incisor retraction aspects. The incisors are intruded, together with bodily movement or controlled tipping. These cases also showed improvements in gummy smile.

Clinical tip ››››

Treatment of cases showing mouth protrusion and gummy smile

- Insert mini-implants between the upper second premolar and first molar, and tightly ligate the mini-implant head with the second premolar bracket.
- Place a compensating curve in the upper wire.

Gummy smile can be improved using these methods.

■ Case 2 (Figure 3-2-1 to 29)

- Age : 25 years 1 month
- Sex : female
- Chief complaint : mouth protrusion

Features of treatment process : four first premolars were extracted and the same mechanics as in Case 1 were used. Torque control of the upper incisors after space closure will be described in detail. It is hoped that the reader will gain good understanding of torque control and apply the techniques clinically.

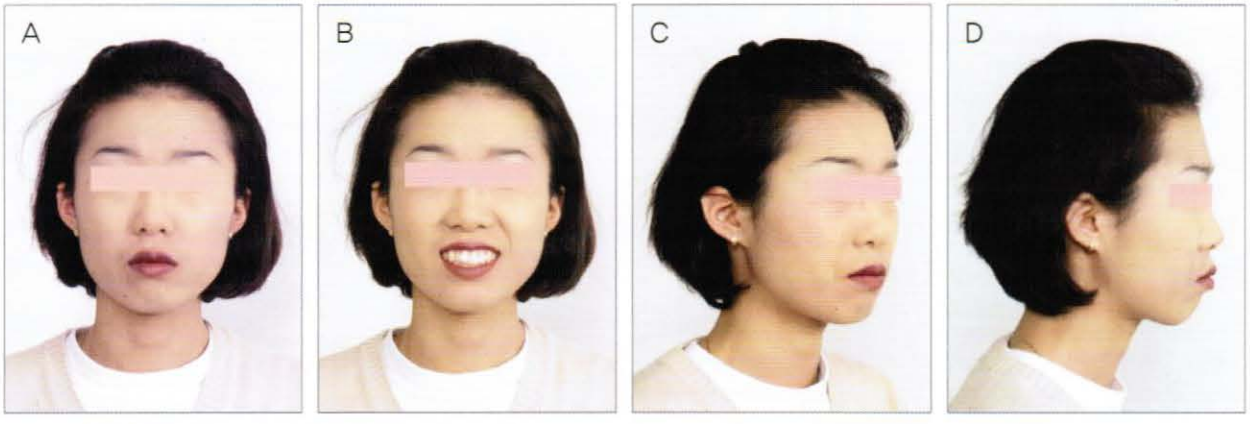


Figure 3-2-1. Pre-treatment facial photograph of Case 2
She shows mouth protrusion and has difficulty with mouth closing. The muscles around the mouth and mentalis muscle show straining during mouth closure.
A. Mentalis muscle strain during closure.
B. Gummy smile on smiling.
C, D. Mouth protrusion, small nasolabial angle, and retrusive chin.

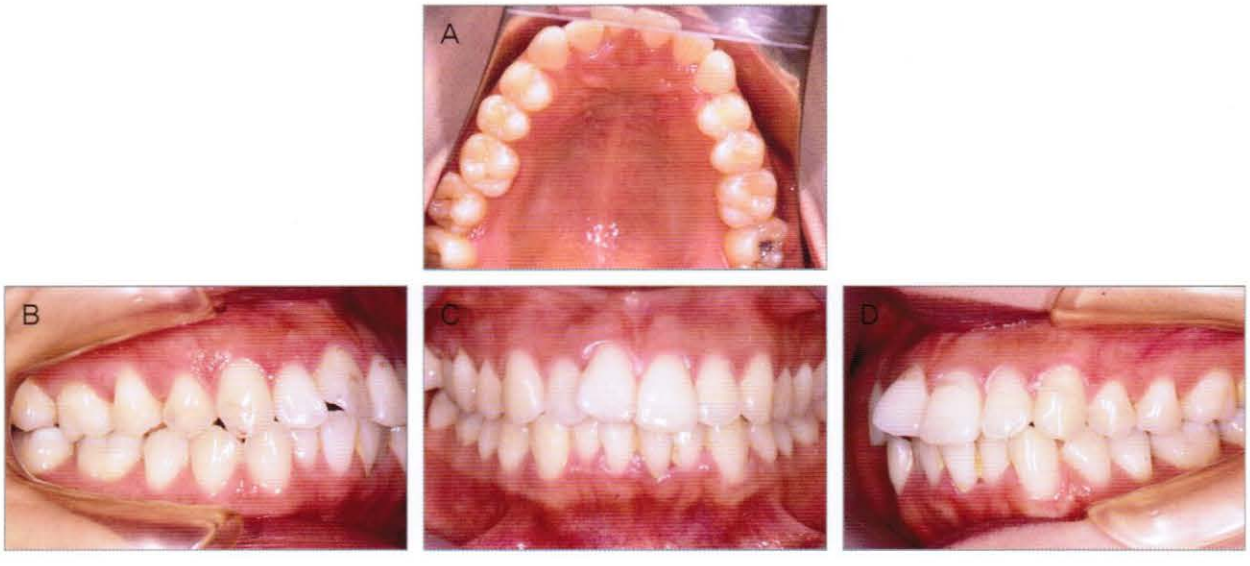
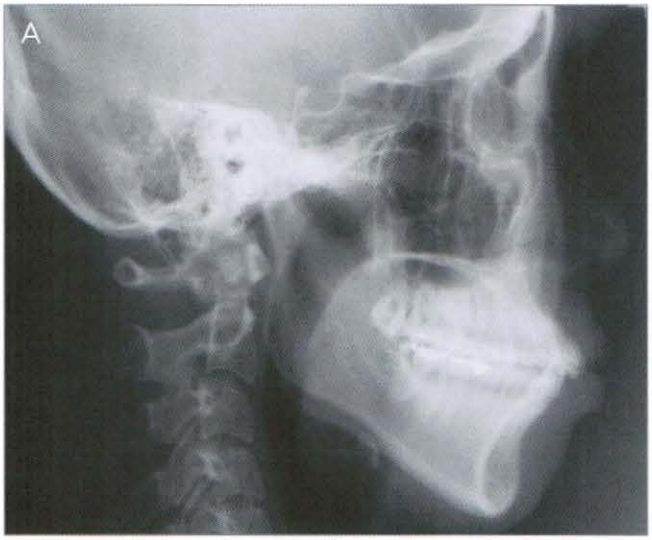
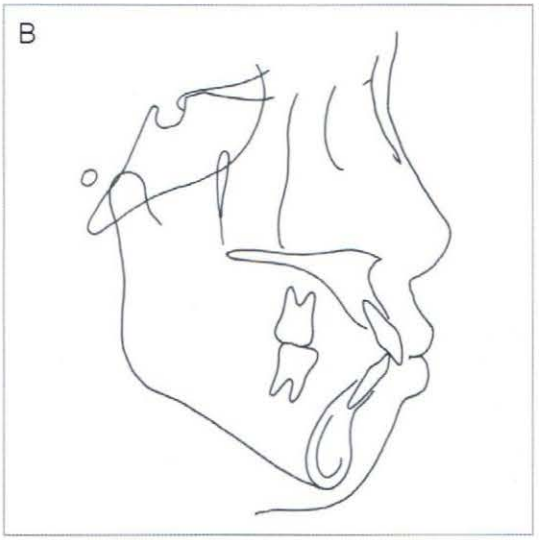


Figure 3-2-2. Pre-treatment intraoral photograph of Case 2
Slight crowding of the upper and lower dentition (A, F).





C

	Norm	SD	T1
SNA	81.6	3.2	79.5
SNB	79.2	3.0	76.5
ANB	2.5	1.8	3.0
FMA	24.3	4.6	30.5
U1 to FH	116.0	5.8	119.0
IMPA	95.9	6.4	95.5
IIA	123.8	8.3	115.0
Esth-U	-0.9	2.2	5.0
Esth-L	0.6	2.3	8.0

Figure 3-2-3. Pre-treatment cephalometric radiograph (A), tracing (B) and measurement (C)
A. Mouth protrusion and small nasolabial angle.
B, C. Anteroposterior skeletal relationship is Class I. She shows a normal vertical skeletal pattern. The upper and lower incisors show labioversion. U1 to FH is 119.0°, IMPA is 95.5°. Interincisal angle (115°) is smaller than average.

Figure 3-2-4. Postero-anterior radiograph
There is no asymmetry.

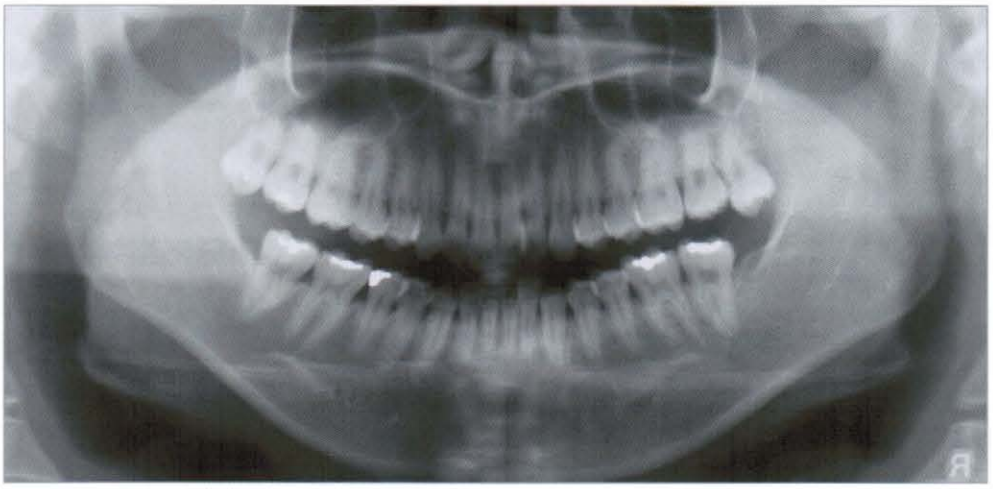


Figure 3-2-5. Pre-treatment panoramic radiograph
Upper third molars are present, with overeruption.

From these data, it was decided to treat the case with four first premolar extractions with reinforced anchorage for maximum retraction. Mini-implants between the upper second premolar and first molar roots will be inserted.

Clinical tip ››››

Good indications for four first premolar extractions

1. Mouth protrusion with an interincisal angle of less than 115~120°.
2. Arch length discrepancy of more than 10mm for each arch.

Treatment Progress

	Upper	Lower
	Leveling	**Leveling**
2001. 10.5	U : 014″ NiTi	L : 014″ NiTi (except for #32 & #42)
2001. 11.9	U : 018″ NiTi	L : 018″ NiTi with open coils for #32 & #42
2001. 12.7	U : 016×022″ NiTi	L : 014″ NiTi after bonding brackets on #32 & #42
	Implantation	
2002. 1.17	U : 1.6×6.2 EA 6↓5|5↓6	
2002. 1.18		L : 018″ NiTi
	Space closing	
2002. 2.8	U : 019×025″ ss with long hooks	L : 016×022″ NiTi
		Space closing
2002. 3.5		L : 018×022″ ss with shoe hooks
	Detailing	**Detailing**
2003. 2.5	U : Repositioning of #12 & #22 brackets, 018″ NiTi	L : 018×022″ ss with shoe hooks (same wire)
2003. 3.25	U : 016×022″ NiTi	
2003. 4.8	U : 019×025″ ss with shoe hooks (crown labial torque)	
	Debonding	
2004. 1.13	Removal of first molar bands	
2004. 1.28	Debonding	**Total : 2 years and 4 months**

After insertion of the first wire, total treatment took 2 years and 4 months. Of this time, 1 year was spent space closing and 1 year for detailing. When treating mouth protrusion with mini-implants as anchorage, linguoversion of the upper incisors occurs due to the large amount of retraction. To compensate, root lingual torque is given at the detailing stage, which takes a long time.

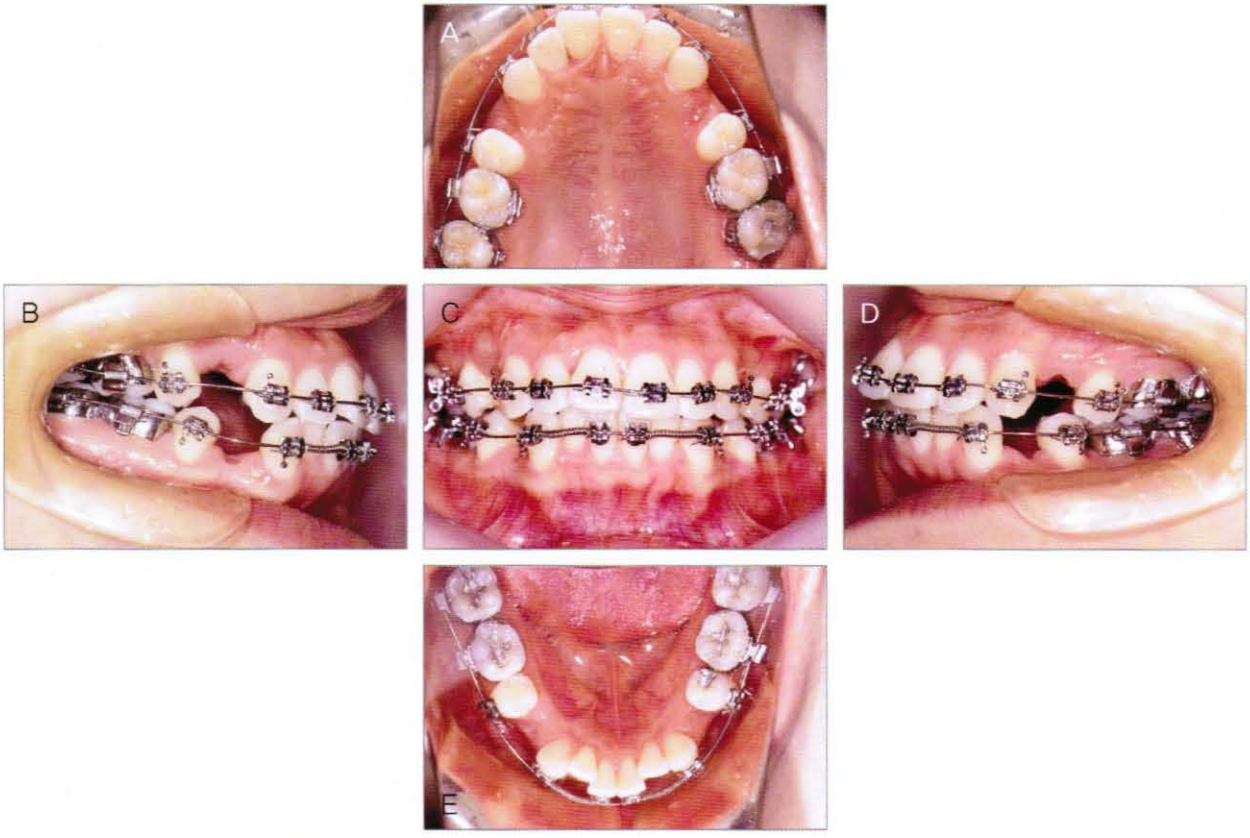
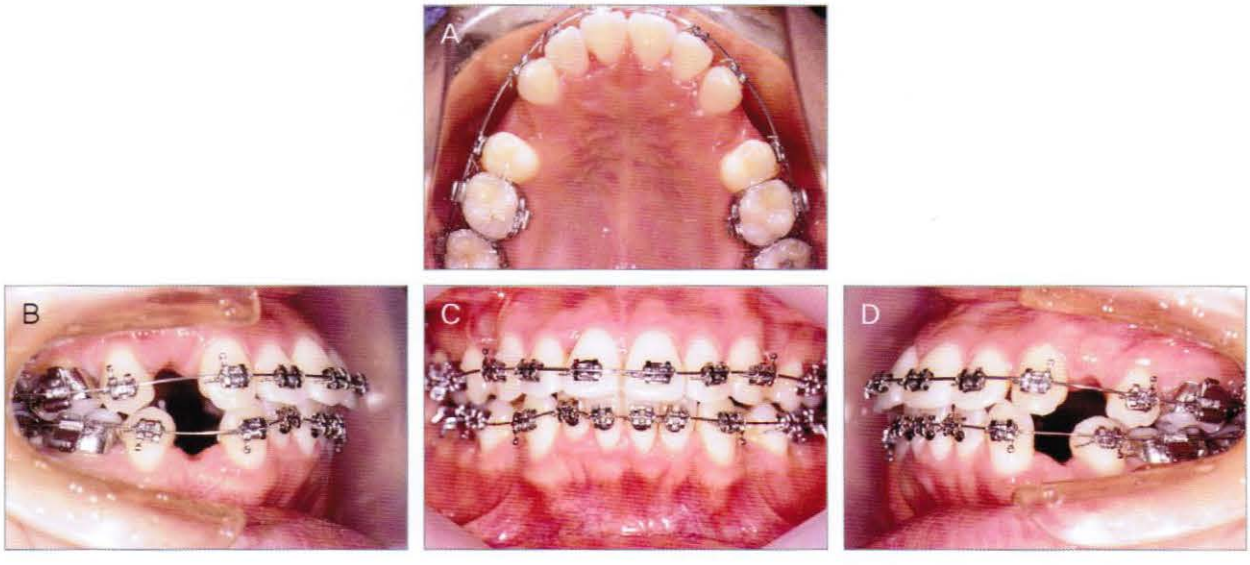


Figure 3-2-6. Leveling stage. Photograph taken after ligation of 018″ NiTi wire (2001. 11.9 – 2 months after start of treatment)
The lower lateral incisors are not yet bonded. Space is being made with open coil spring. Open coil should be inserted with stiff wire of 018″ ss or higher. If a flexible wire such as 018″ NiTi is to be used, the open coil spring should be applied with a lighter force.



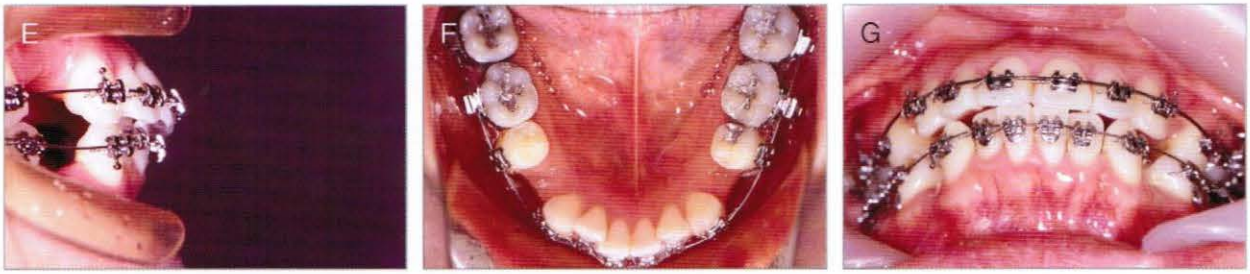


Figure 3-2-7. Leveling stage. Photograph taken with 016×022″ NiTi in the upper arch and 014″ NiTi wire in the lower arch (2001. 12.7 – 3 months after start of treatment)
After making room for the lower lateral incisors, 014″ NiTi wire is ligated to include the lateral incisors.

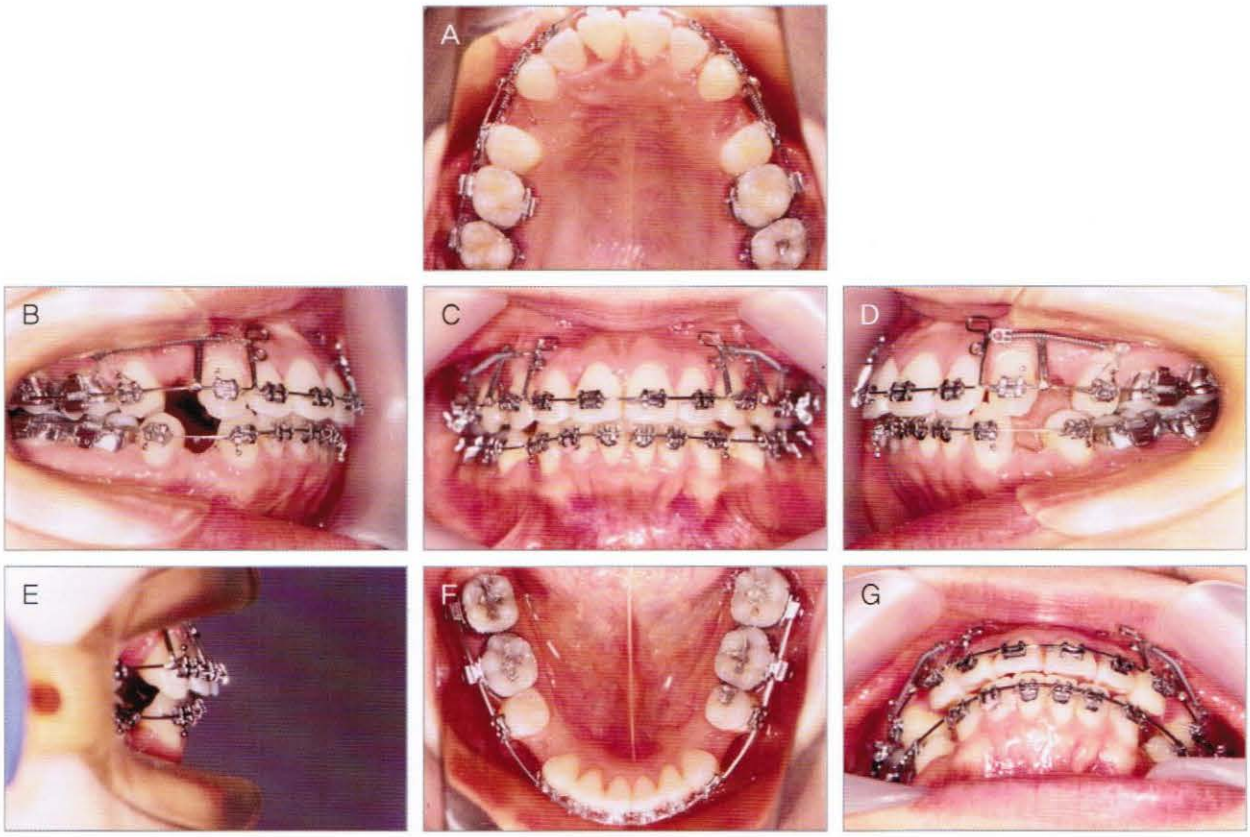


Figure 3-2-8. Space closure stage (2002. 2.8 – 5 months into treatment)
Space closure is begun using sliding mechanics on a 019×025″ ss wire. The lower arch is in the last stages of leveling with 016×022″ NiTi wire.
In the upper arch, after leveling to 016×022″ NiTi wire, 6mm mini-implants were inserted between the second premolar and first molar (Refer to space closing mechanics shown in Figure 3-1-14).

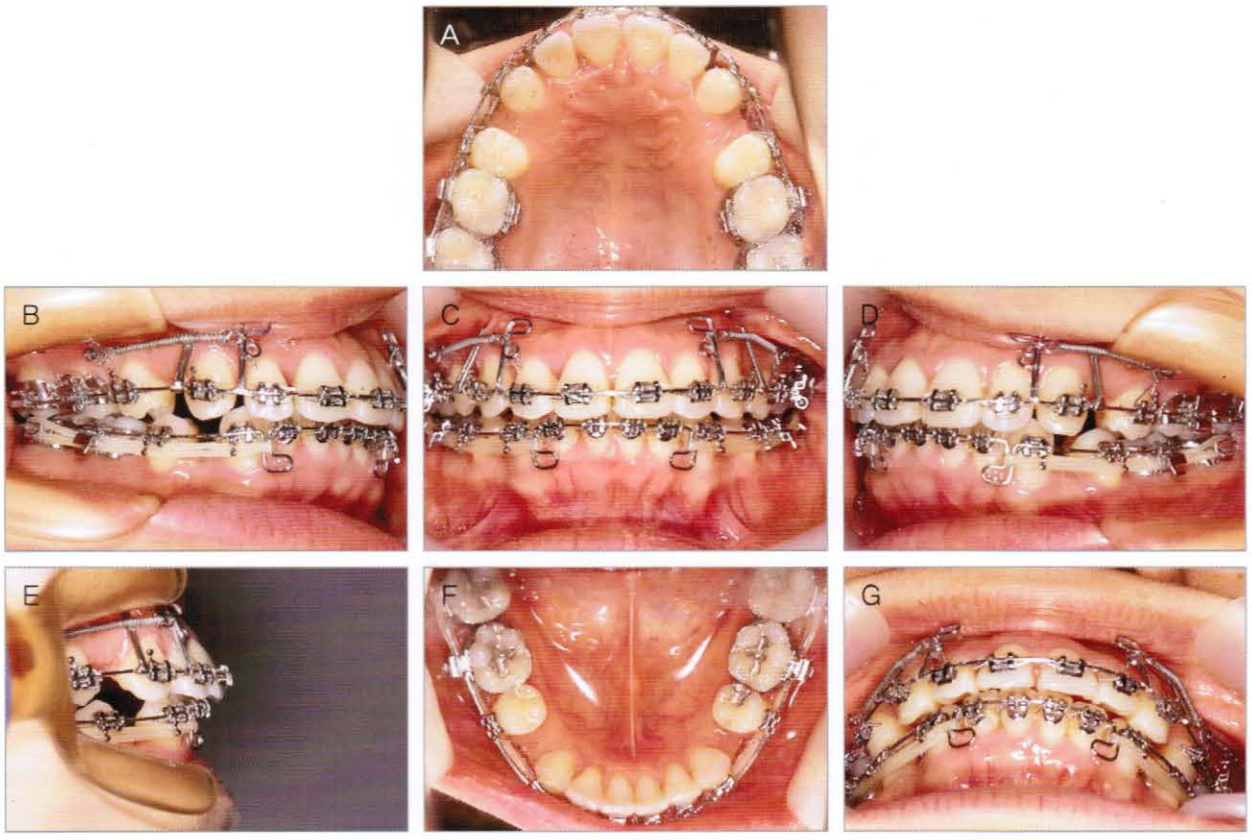


Figure 3-2-9. Space closing stage (2002. 4.12 – 7 months into treatment)
018×022″ ss with shoe hooks is ligated onto the lower arch, and 5/16″ 6 oz Class I elastics are used for space closure (Refer to space closing mechanics shown in Figure 3-1-14).

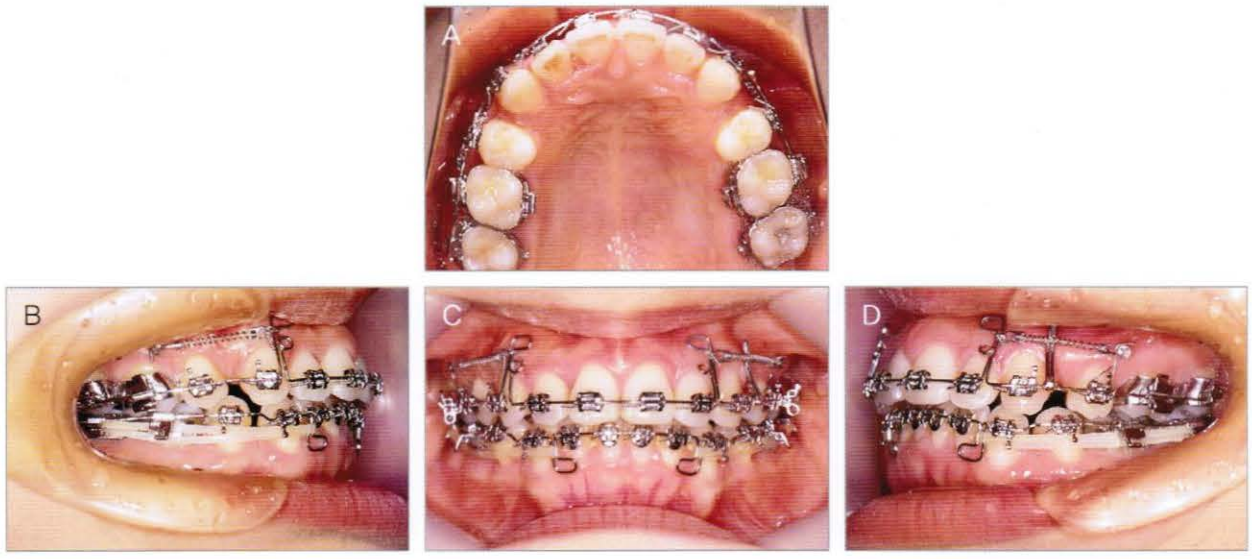


Figure 3-2-10. Space closing stage (2002. 8.30 – 12 months into treatment)

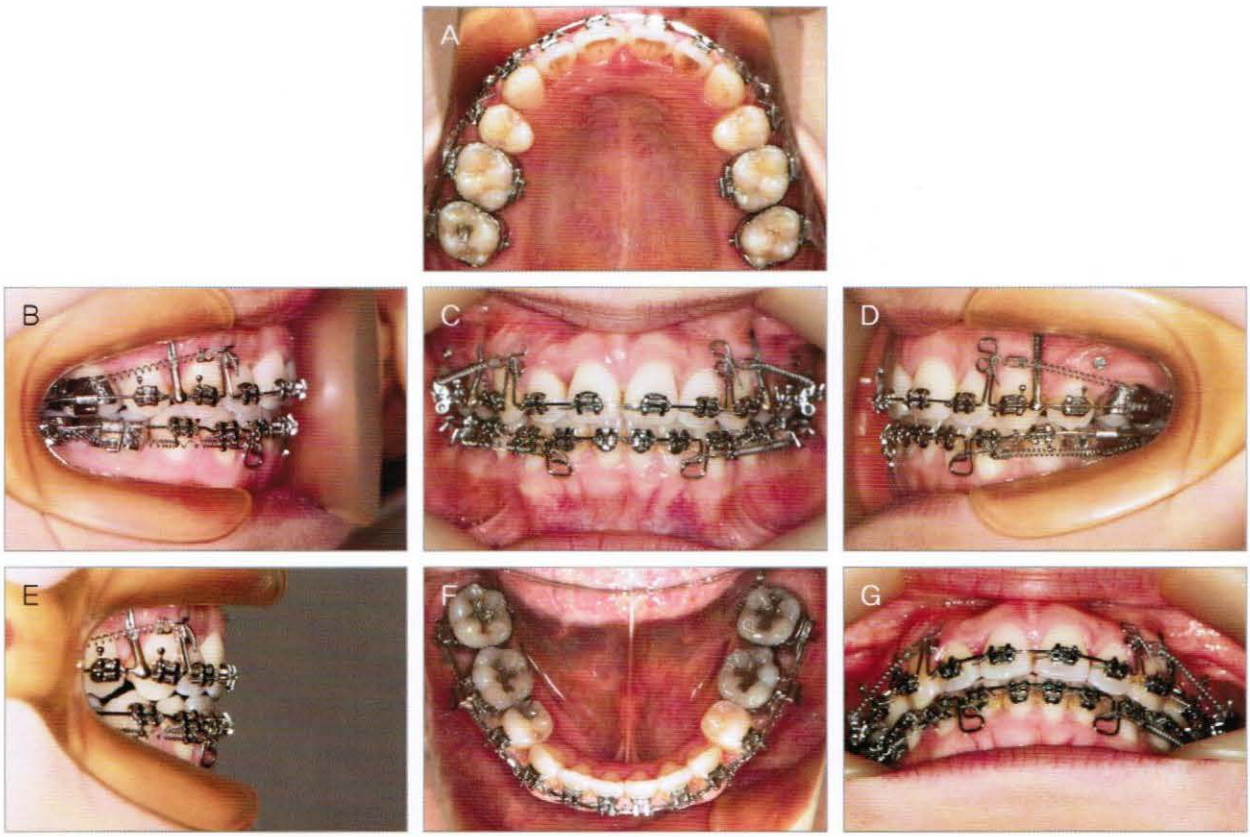
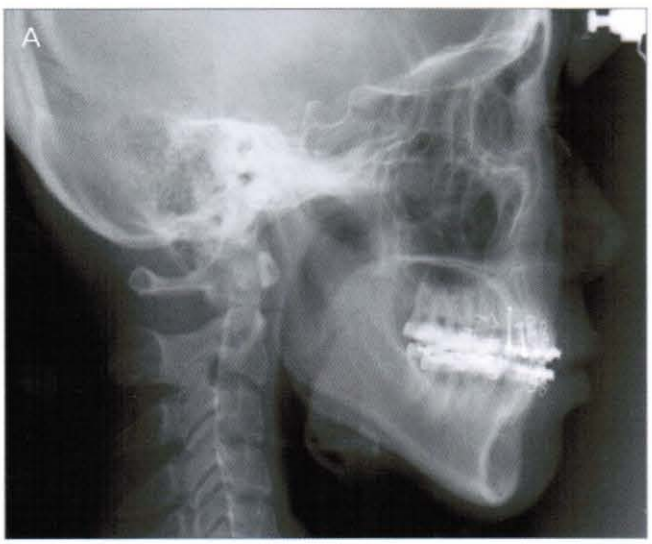


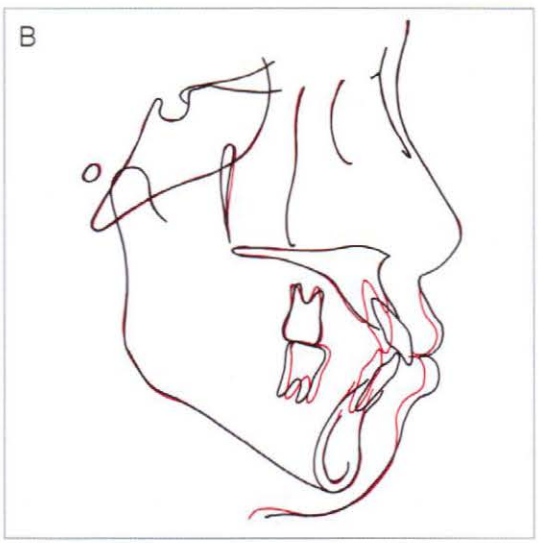
Figure 3-2-11. Completion of space closure (2003. 1.7 – 16 months into treatment)

Clinical tip ››››

Time required for space closure using mini-implants in mouth protrusion cases

At least 7 months. Using traditional methods, the upper canines are retracted first, then the 4 incisors. However when mini-implants are used, the upper 6 anterior teeth are retracted together because posterior anchorage has been reinforced. Theoretically when 6 anterior teeth are retracted en masse with mini-implants as anchorage, space closing time is expected to be shortened by half the time required with conventional methods. However, this is not so. This is because using the traditional method, space closing occurs with some mesial loss of the molars, whereas with mini-implants molar loss is not permitted. Also because a larger amount of incisor retraction is carried out, more linguoversion of the incisors is inevitable. More time is required at the detailing stage for giving lingual root torque. Therefore total treatment time is not shortened a great deal.





C

	Norm	SD	T1	T2
SNA	81.6	3.2	79.5	78.5
SNB	79.2	3.0	76.5	76.5
ANB	2.5	1.8	3.0	2.0
FMA	24.3	4.6	30.5	30.5
U1 to FH	116.0	5.8	119.0	102.5
IMPA	95.9	6.4	95.5	85.0
IIA	123.8	8.3	115.0	142.5
Esth-U	-0.9	2.2	5.0	2.5
Esth-L	0.6	2.3	8.0	3.5

Figure 3-2-12. Cephalometric radiograph and measurement after space closure
A. Cephalometric radiograph shows relief of mouth protrusion.
B. Superimposition of before and after space closure.
The first molars have not overerupted or moved mesially. The upper incisors have been retracted a fair amount. Controlled tipping has occurred, but some linguoversion is inevitable as the amount of incisor retraction is large.
C. U1 to FH has decreased to 102.5°. Linguoversion of the upper incisors is esthetically and functionally unfavorable. Upper incisor root lingual torque is required (Refer to Methods of giving upper incisor root lingual torque, Figure 3-2-28, 29).

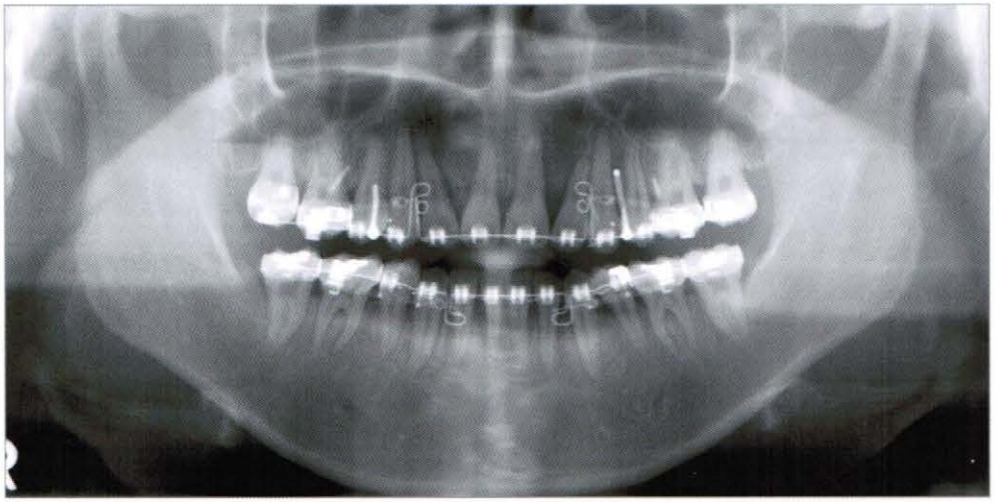


Figure 3-2-13. Panoramic radiograph after space closure
The upper lateral incisor roots are tilted distally. Figure 3-2-14 shows adjustment methods.

Clinical tip ››››

Cephalometric radiograph (Figure 3-2-11) and panoramic radiograph (Figure 3-2-12) should be taken after space closure and the following points checked.

1. Upper incisor inclination (U1 to FH, IMPA) : decide whether torque change is required.
2. Root parallelism: using Roth set-up or MBT set-up, the canine roots are tilted distally, the second premolar roots are tilted slightly mesially, and the two roots are shown to converge (this may be seen as overcorrection to prevent re-opening of the space). All other roots should be parallel.
3. Root resorption: treatment may be discontinued if root resorption has progressed.

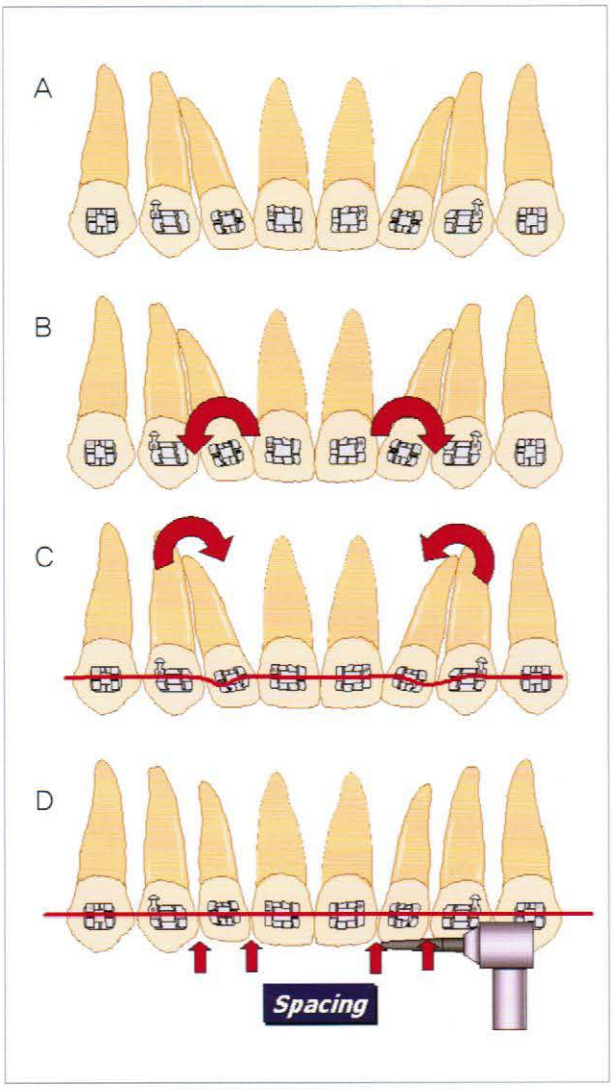


Figure 3-2-14. Control of upper lateral incisor roots
A. The roots of the upper lateral incisors show distal tipping on panoramic radiograph (Figure 3-2-13).
B. Bracket is rebonded in the correct position.
C. Re-leveling is carried out. This will cause space opening between the central and lateral incisors (Figure 3-2-17).
D. Close the spaces between teeth and reshape the incisal edge of the lateral incisor if required. Compare the changes in root axis with the post-treatment radiograph (Figure 3-2-21).

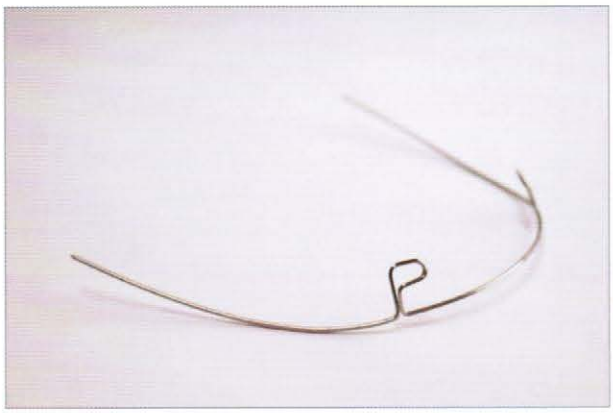


Figure 3-2-15. Wire to apply root lingual torque to the upper incisors
On a 019×025" ss wire with shoe hooks, a 5~10° (adjust accordingly and increase gradually) root lingual torque is applied. First use flat, then apply a compensating curve around 3~6 weeks later. Lingual root torque is increased. 5/16" 6 oz Class II elastics are used at this stage to prevent labioversion and spacing of the upper incisors.

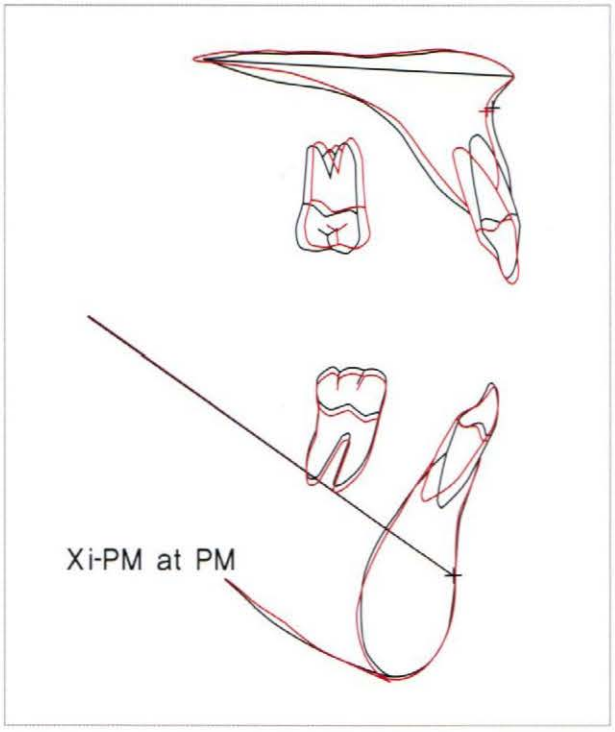


Figure 3-2-16. Changes after applying upper incisor lingual root torque
Superimposition of tracing before and after applying lingual root torque. The upper incisor root tip has moved distally.

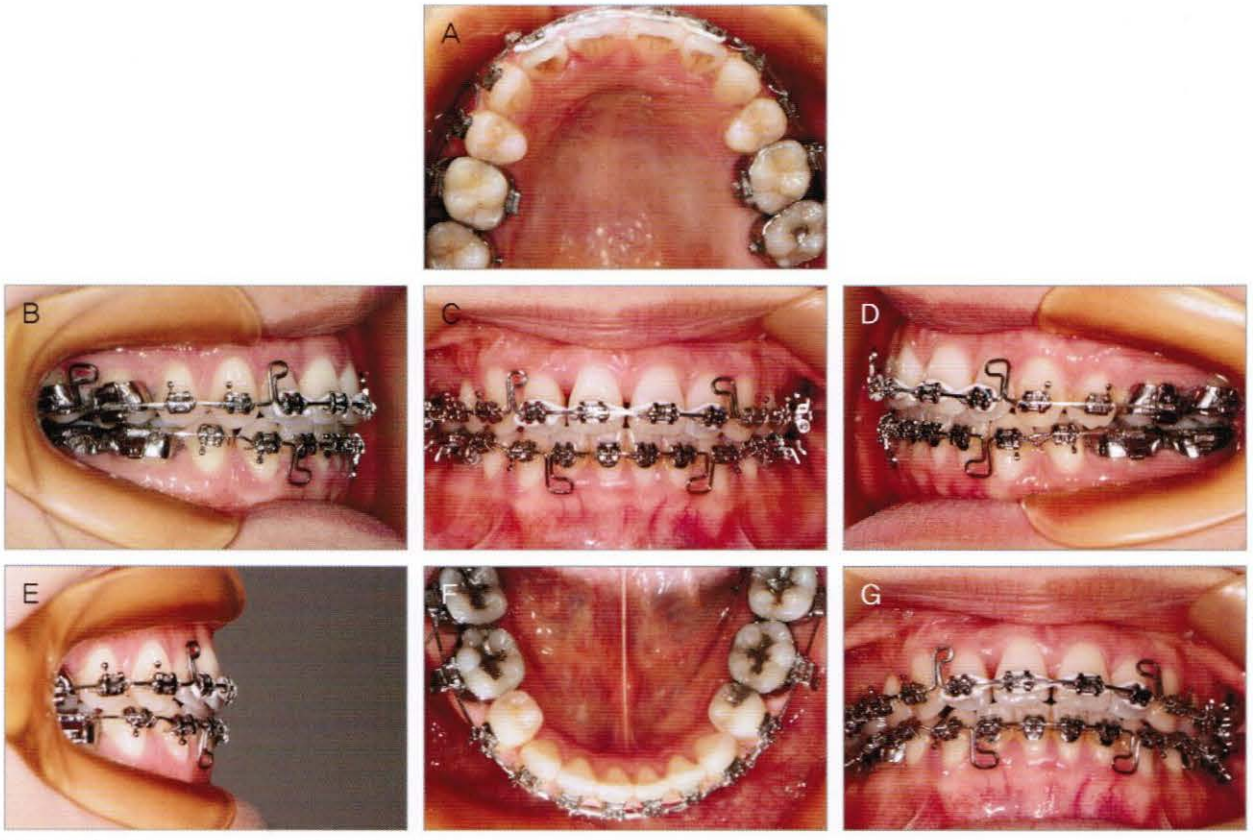


Figure 3-2-17. Finishing stage (2003. 4.6)
Upper incisor root torque and lateral incisor root tip are being corrected. Spacing has occurred between the upper incisors. Spaces are closed using elastic thread, and 5/16" 6 oz Class II elastics are used to prevent incisor labioversion.

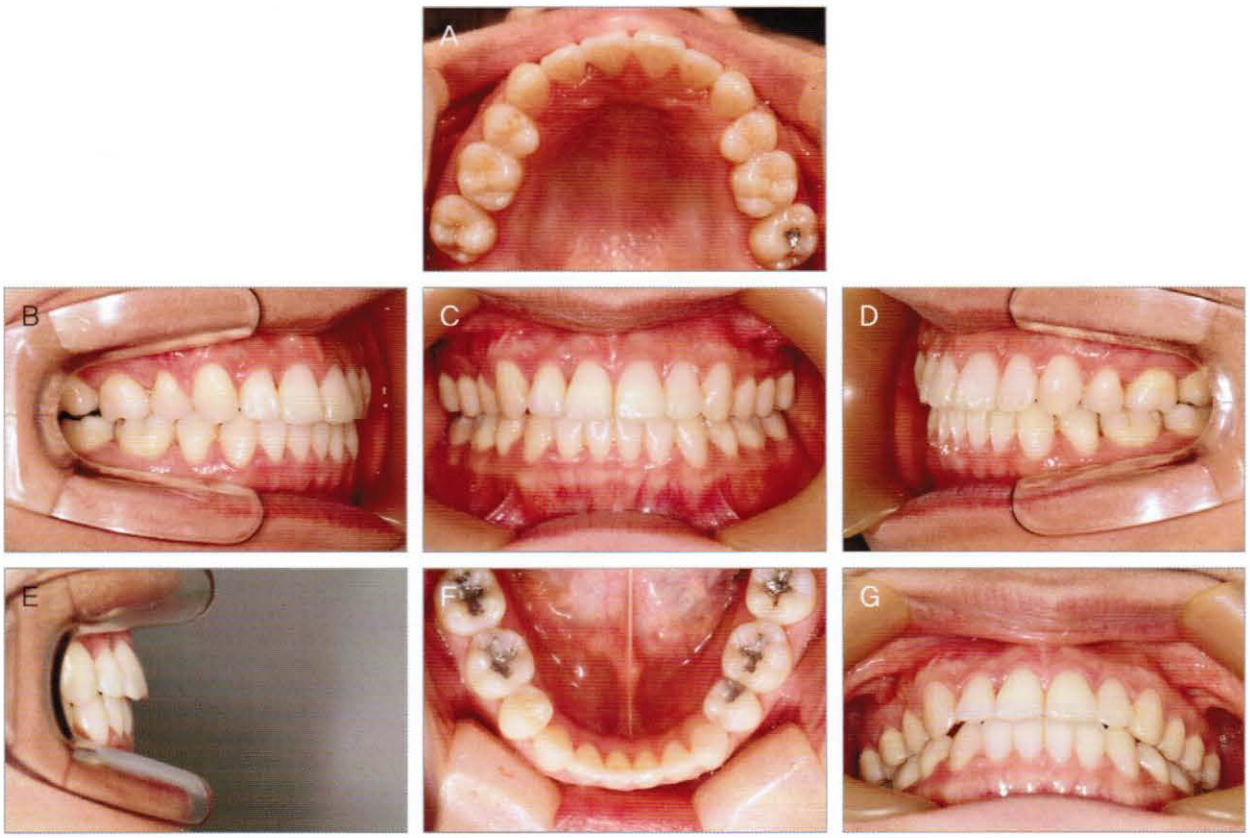


Figure 3-2-18. Intraoral photograph at debonding (2004. 2.11)
Good alignment has been achieved. Although the occlusion is slightly open in the upper right molar region, it was explained to the patient that natural extrusion of the tooth will improve the bite in time (B).

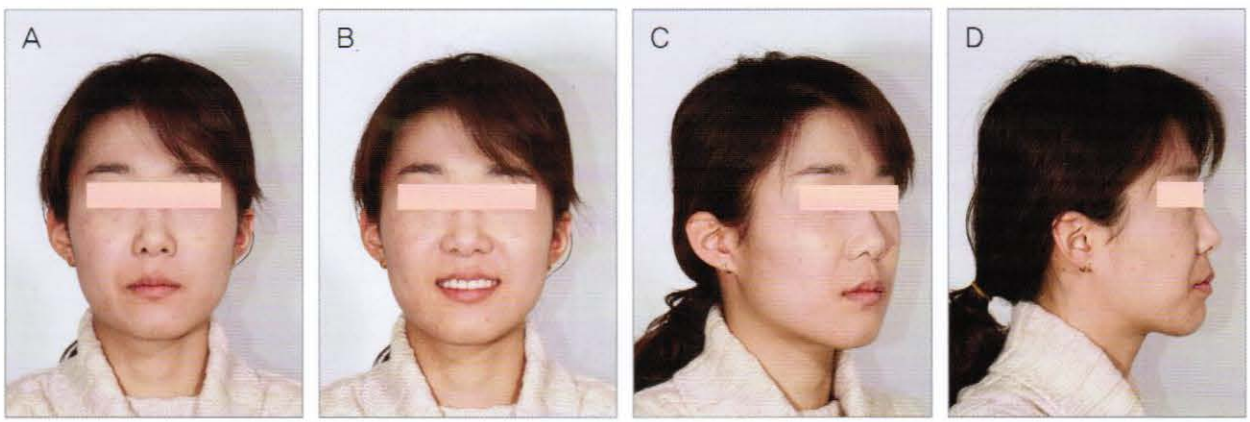
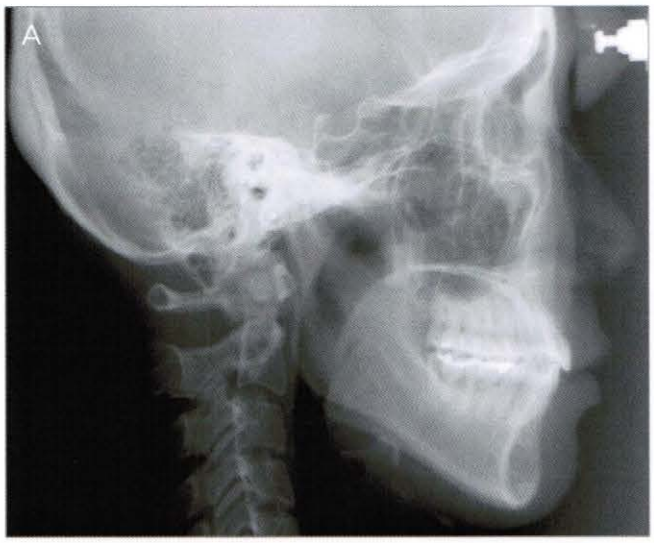
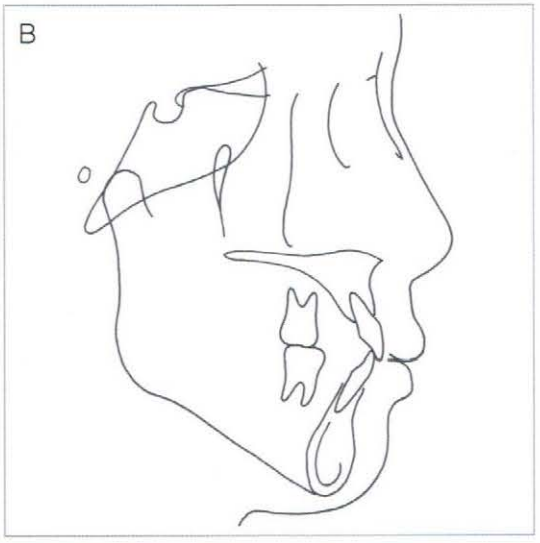
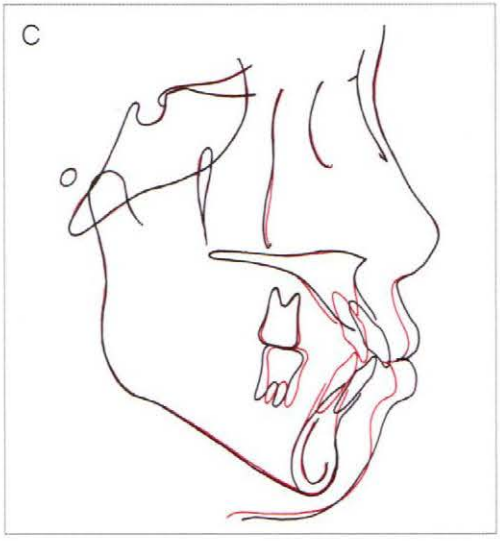


Figure 3-2-19. Facial photograph at debonding (2004. 2.11)
A. Tension of the muscles around the mouth during lip closure has disappeared.
B. Gingival exposure during smiling has decreased.
C. With treatment of mouth protrusion, the nose looks relatively higher.
D. She shows an esthetic profile with treatment of mouth protrusion.







D

	Norm	SD	T1	T2	T3
SNA	81.6	3.2	79.5	78.5	78.0
SNB	79.2	3.0	76.5	76.5	76.0
ANB	2.5	1.8	3.0	2.0	2.0
FMA	24.3	4.6	30.5	30.5	31.7
U1 to FH	116.0	5.8	119.0	102.5	114.8
IMPA	95.9	6.4	95.5	85.0	89.0
IIA	123.8	8.3	115.0	142.5	124.6
Esth-U	−0.9	2.2	5.0	2.5	0.6
Esth-L	0.6	2.3	8.0	3.5	1.9

Figure 3-2-20. Cephalometric radiograph and measurement at debonding
A. Cephalometric radiograph shows mouth protrusion has been resolved.
B. Cephalometric tracing after debonding.
C. Superimposition of pre- and post-treatment. The upper and lower incisors have been retracted through bodily movement. The upper incisors have been intruded slightly.
D. The upper and lower incisors show normal axes. U1 to FH is 114.8° and IMPA is 89.0°.

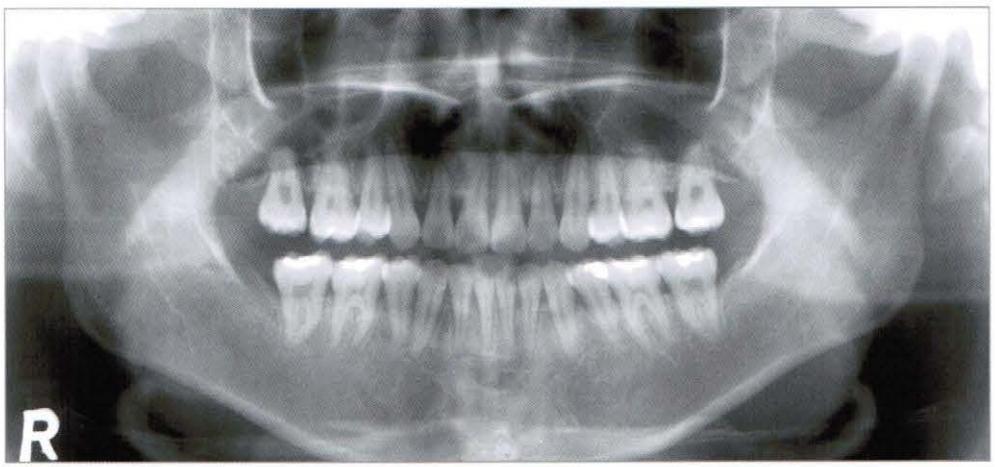


Figure 3-2-21. Panoramic radiograph at debonding
The upper lateral incisor root axis has been corrected.

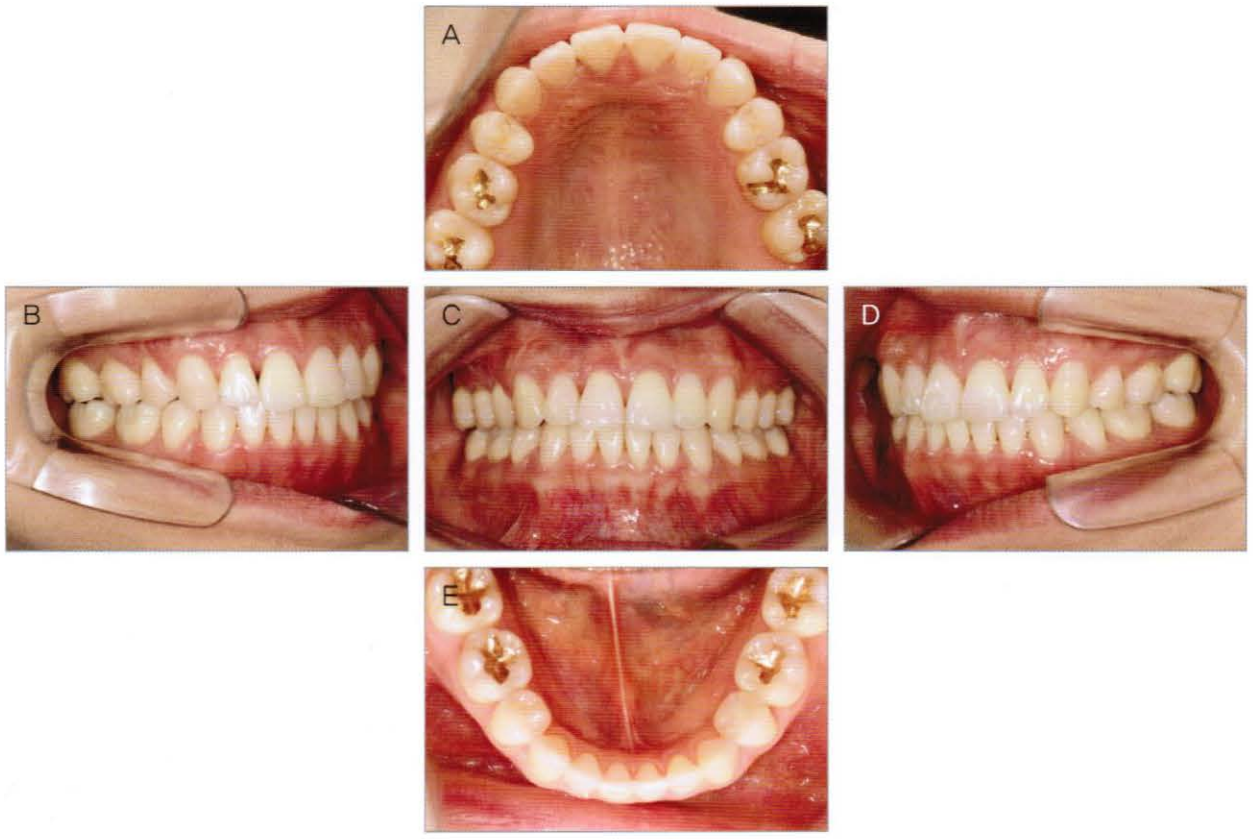


Figure 3-2-22. Intraoral photograph at 15 months post-retention (2005. 5.16)
Good interdigitation of the upper right first molar has been achieved (B).

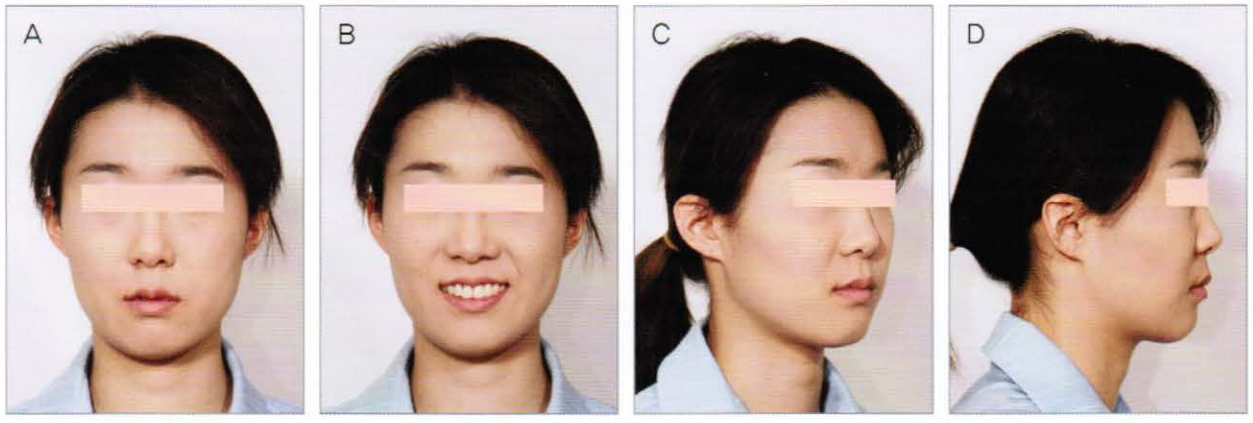


Figure 3-2-23. Facial photograph at 15 months post-retention (2005. 5.16)

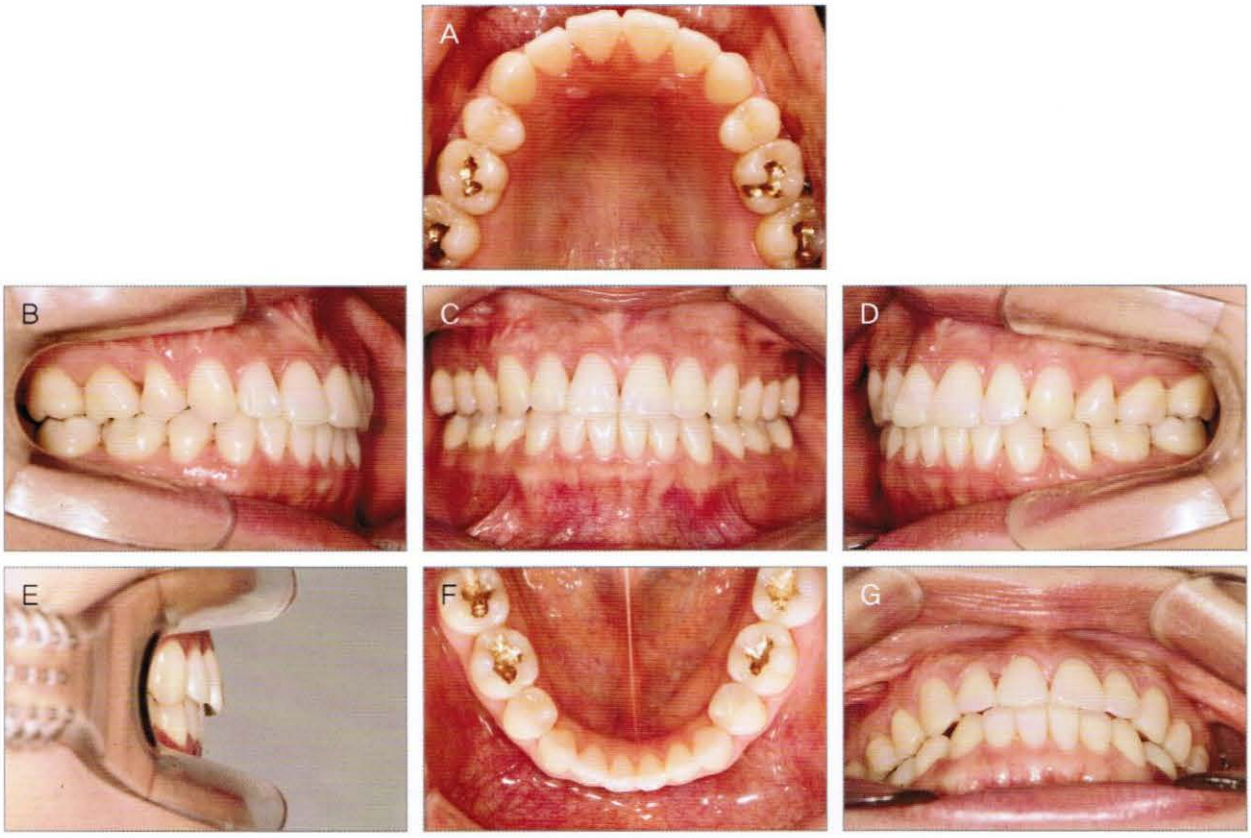


Figure 3-2-24. Intraoral photograph at 22 months post-retention (2005. 12.6)
Treatment is being well maintained.

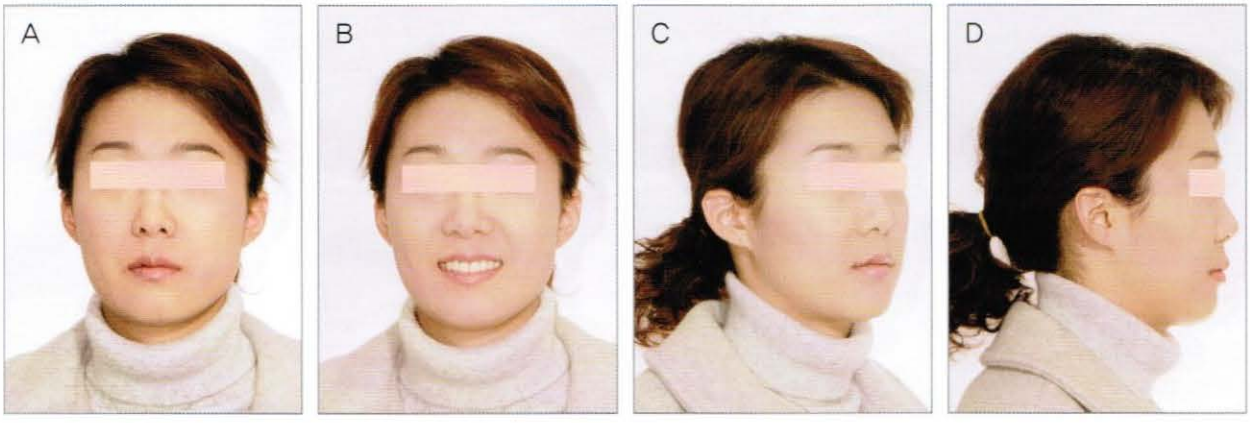


Figure 3-2-25. Facial photograph at 22 months post-retention (2005. 12.6)

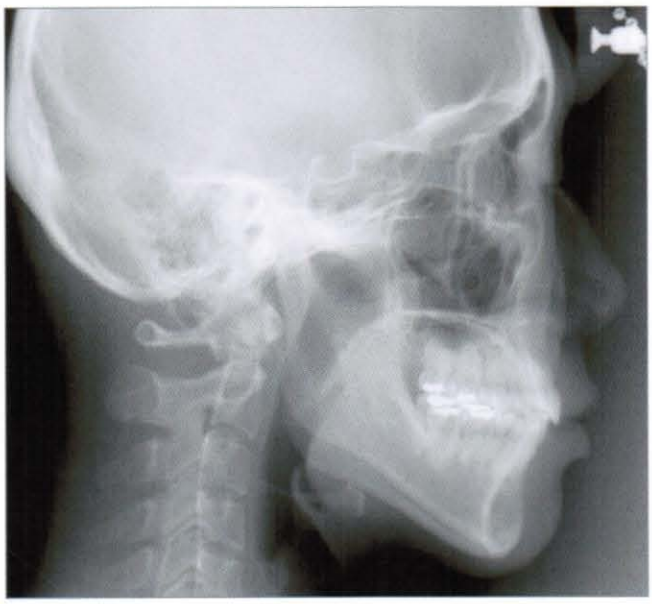


Figure 3-2-26. Cephalometric radiograph at 22 months post-retention (2005. 12.6)

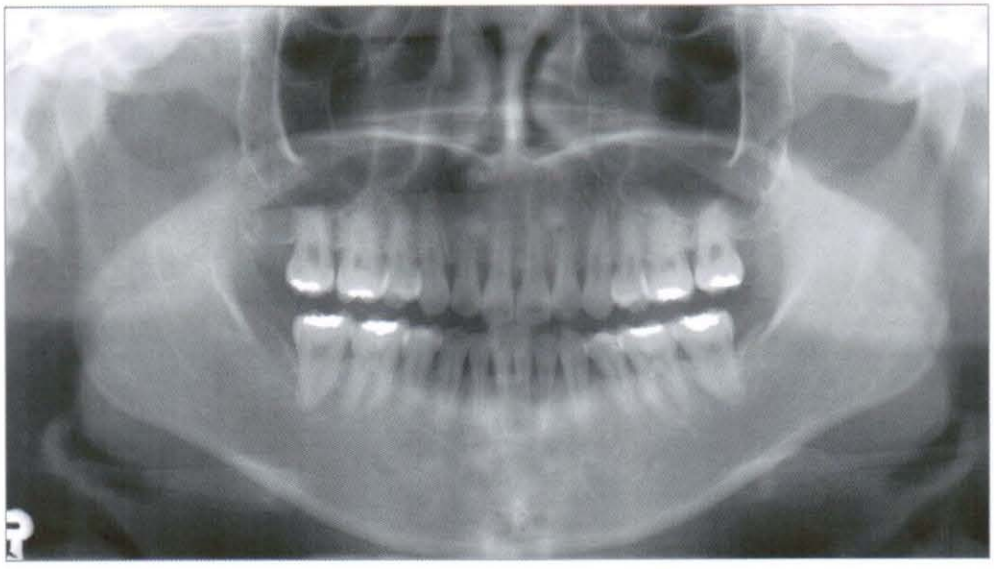


Figure 3-2-27. Panoramic radiograph at 22 months post-retention (2005. 12.6)

Clinical tip ››››

Methods of applying lingual root torque to upper 019x025 ″ ss wire with shoe hooks

There are many methods, but here, methods of applying lingual root torque to an already made 019x025 ″ ss wire with shoe hooks is explained.

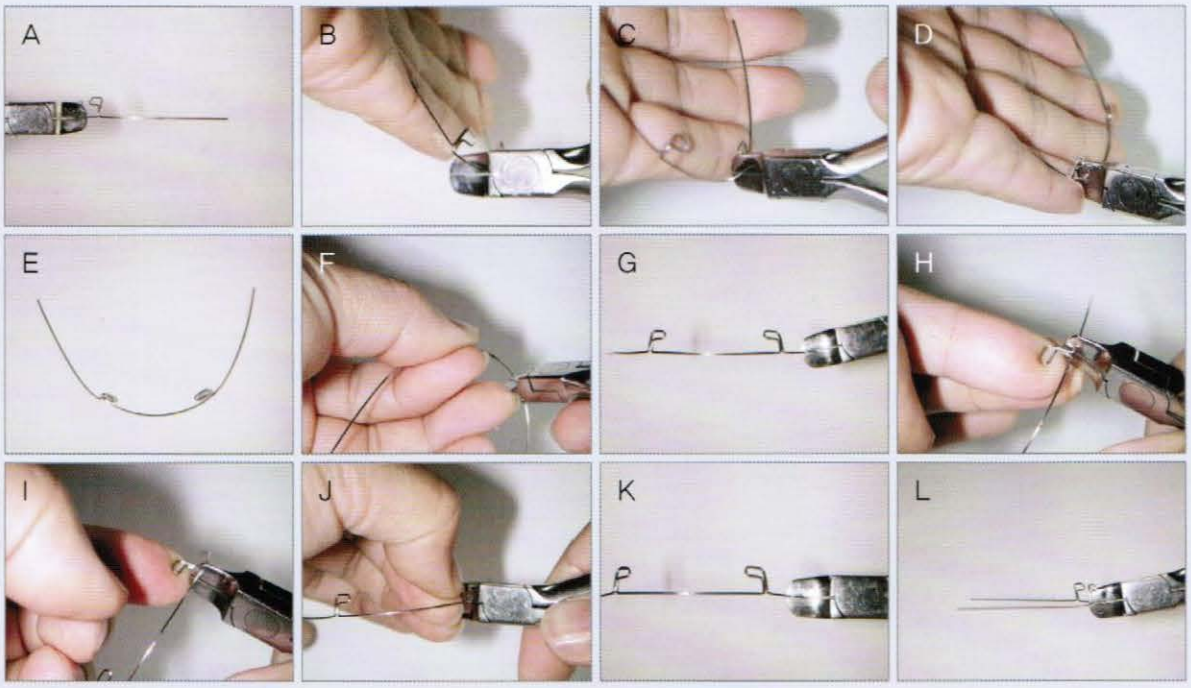


Figure 3-2-28. Applying lingual root torque to the upper incisors

A. A 019×025 ″ ss wire with shoe hooks is needed.

B, C, D. Hold the middle portion with tweed arch forming pliers, and push the free end portion up. Repeat this procedure while moving the holding point between the shoe hooks.

E. During this procedure, the back portion is widened to form a wide arch form, and unnecessary posterior torque is applied. Both shoe hooks are leaning lingually.

F. The widened arch form is corrected.

G. Unnecessary posterior torque has been applied.

H. Hold the back part of the shoe hook and push the shoe hook labially.

I. Now hold the front part of the shoe hook and push the shoe hook the same amount labially.

J. Holding the shoe hook with the fingers, remove the posterior torque with pliers by rotating down.

K. By removing the posterior torque, check that the axis of the plier and wire are in the same plane. When this is achieved, the posterior torque is 0°.

L. Anterior torque still remains.

Clinical tip ››››

Methods of applying compensating curve to upper 019x025 ″ ss wire with shoe hooks

There are two methods. The wire is held from the back of the shoe hook using tweed arch forming plier and the wire is bent up while moving backwards (Figure 3-2-29 A~D). In the other method, the wire is held at the back of the shoe hook with tweed arch forming plier and the free end of the wire is bent up with the thumb and forefinger through wiping (Figure 3-2-29 F~H).

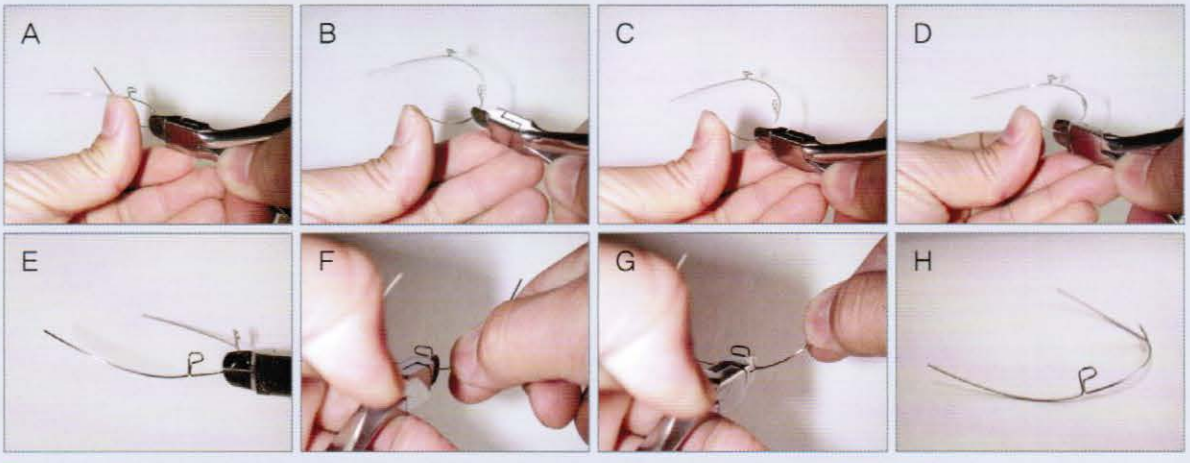


Figure 3-2-29. Methods of applying compensating curve to upper 019×025 ″ ss wire with shoe hooks
A~D. The wire is held from the back of the shoe hook using tweed arch forming plier and the wire is bent up while moving backwards.
E. Curve has been applied only on the right side.
F~H. The wire is held at the back of the shoe hook with tweed arch forming plier and the free end of the wire is bent up with the thumb and forefinger through wiping.

■ Case 3 (Figure 3-1-1 to 17)

In contrast to the first two cases, this patient shows a Class III skeletal pattern. Because the posterior anchorage is strong enough in the mandible, mini-implants are not used in the mandible. However in this case, mini-implants were inserted between the lower second premolar and first molar for maximum retraction of incisors.

- Age : 12 years 8 months
- Sex : female
- Chief complaint : mouth protrusion

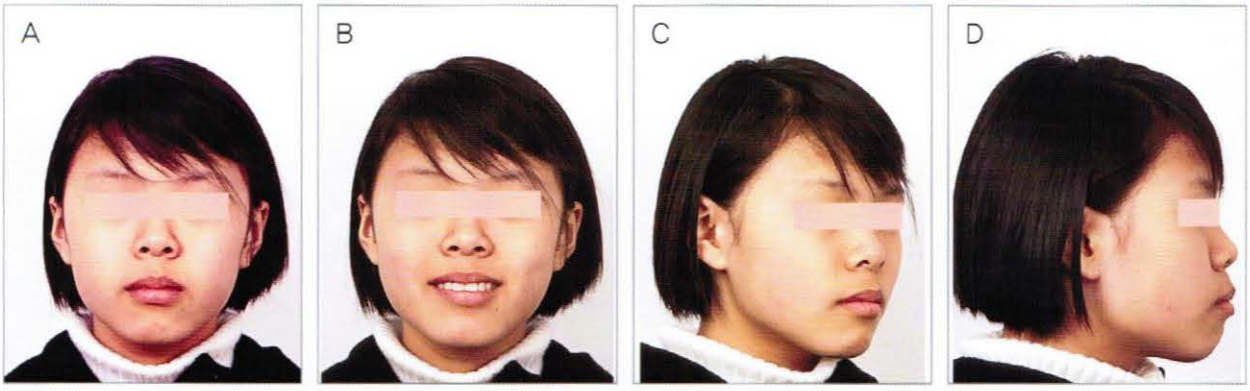


Figure 3-3-1. Pre-treatment facial photographs of Case 3
The mouth and tip of the chin are protruded. Nasolabial angle is small.

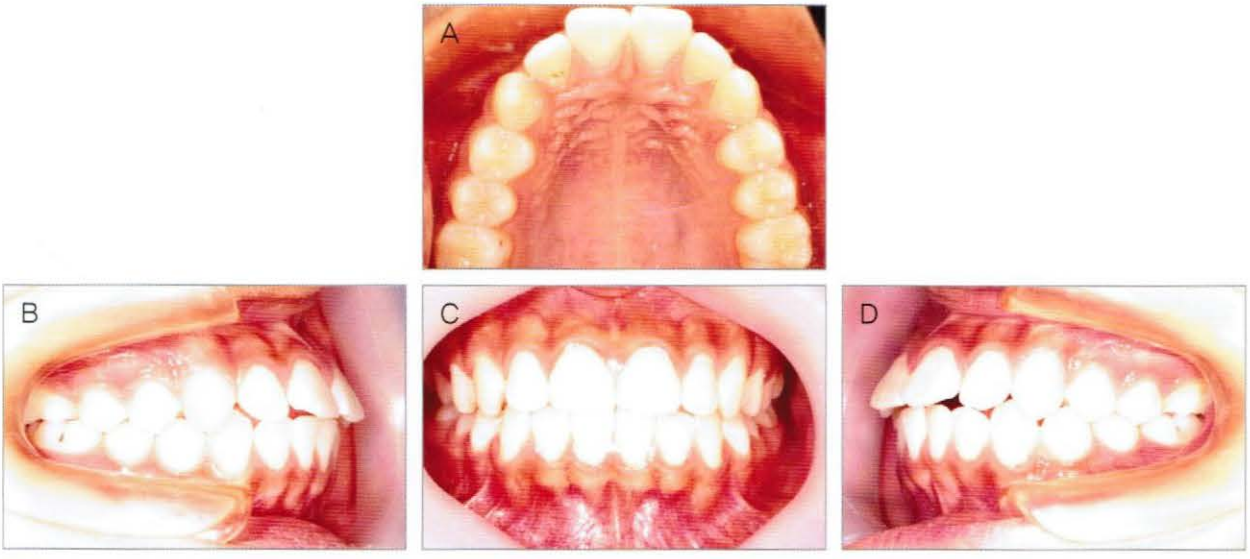
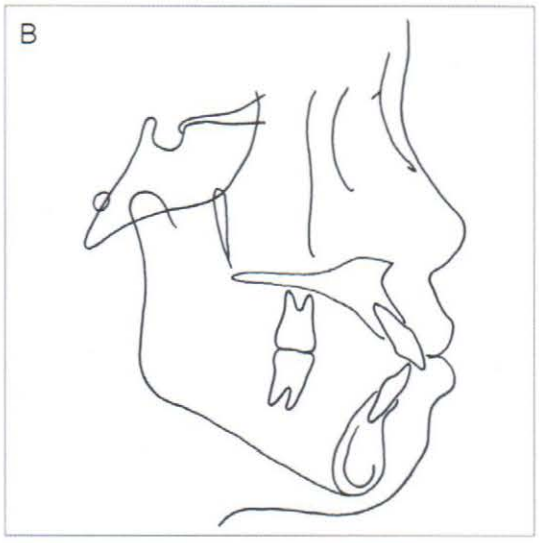


Figure 3-3-2. Pre-treatment intraoral photographs of Case 3
There is slight crowding of the upper and lower dentition (A, F). Canine and first molars are in a Class I relationship (B, D). There is slight open bite (G). She has a lip biting habit.



C

	Norm	SD	T1
SNA	81.6	3.2	75.7
SNB	79.2	3.0	76.2
ANB	2.5	1.8	-0.5
FMA	24.3	4.6	27.6
U1 to FH	116.0	5.8	126.8
IMPA	95.9	6.4	95.7
IIA	123.8	8.3	110.0
Esth-U	-0.9	2.2	1.7
Esth-L	0.6	2.3	5.1

Figure 3-3-3. Pre-treatment cephalometric radiograph (A), tracing (B) and measurement (C)
A. She shows mouth protrusion, small nasolabial angle and slight anterior open bite.
B, C. Antero-posterior skeletal pattern can be said to be slight Class III. There is minor anterior open bite but the vertical skeletal pattern is normal. The upper and lower incisors show labioversion. U1 to FH is 126.8°, and IMPA is 95.7° Interincisal angle (110.0°) is much smaller than the norm.

Figure 3-3-4. Postero-anterior radiograph
There is no asymmetry.

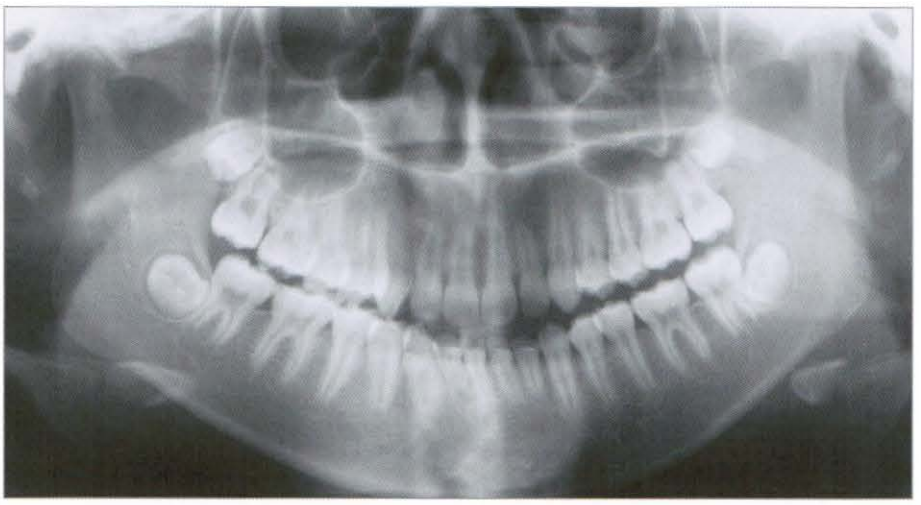


Figure 3-3-5. Pre-treatment panoramic radiograph
All the third molars are present. There was bilateral disk displacement with reduction on MRI but no bony changes to the condyle.

Figure 3-3-6. Pre-treatment hand-wrist x-ray shows growth remaining.

Treatment Progress

■ Leveling — 3 months
- 2002. 6.11 — 014″ NiTi
- 2002. 7.9 — 018″ NiTi
- 2002. 8.8 — 016×022″ NiTi

■ Space closing — 1 month
- 2002. 9.17 — 018×022″ ss with shoe hooks
  + Class I 5/16″ 6oz elastics

■ Implantation
- 2002. 10.17 — 1.6×6.0 4EA $\frac{6\downarrow 5|5\downarrow 6}{6\uparrow 5|5\uparrow 6}$

■ Space closing II — 25 months
- 2002. 10.25 — U : 019×025″ ss with long hooks
  L : 018×022″ ss with shoe hooks
  NiTi closed coil spring
- 2003. 6.17 — Removal of implants
  + U : 019×025″ ss with shoe hooks
  (crown labial torque)

■ Detailing — 3 months
- 2004. 10.30 — Repositioning of #36 bracket
  016″ ss
- 2004. 11.26 ~ 2005. 2.1 — 018×022″ ss with shoe hooks
  Class I elastics 5/16″ 6 oz
  U/D elastics 3/16″ 6 oz

■ Debonding
- 2005. 2.1

Total 32 months

This is a good case for treatment with 4 first premolar extractions. On such patients which show bilateral disk displacement with reduction on MRI, it is important to refrain from using Class III elastics. For the first month, space closure without anchorage reinforcement was attempted. Mini-implants were inserted the next month for space closure, both in the upper and lower dentition between the second premolar and first molar. Mid-way through incisor retraction, mouth protrusion had been corrected and the incisors showed linguoversion. It was decided to remove the mini-implants and allow mesial movement of the posterior teeth. Because in this case the mandible is protruded with a prominent chin, only a small amount of retraction has a large effect on facial profile. Total treatment time was lengthened due to poor patient compliance.

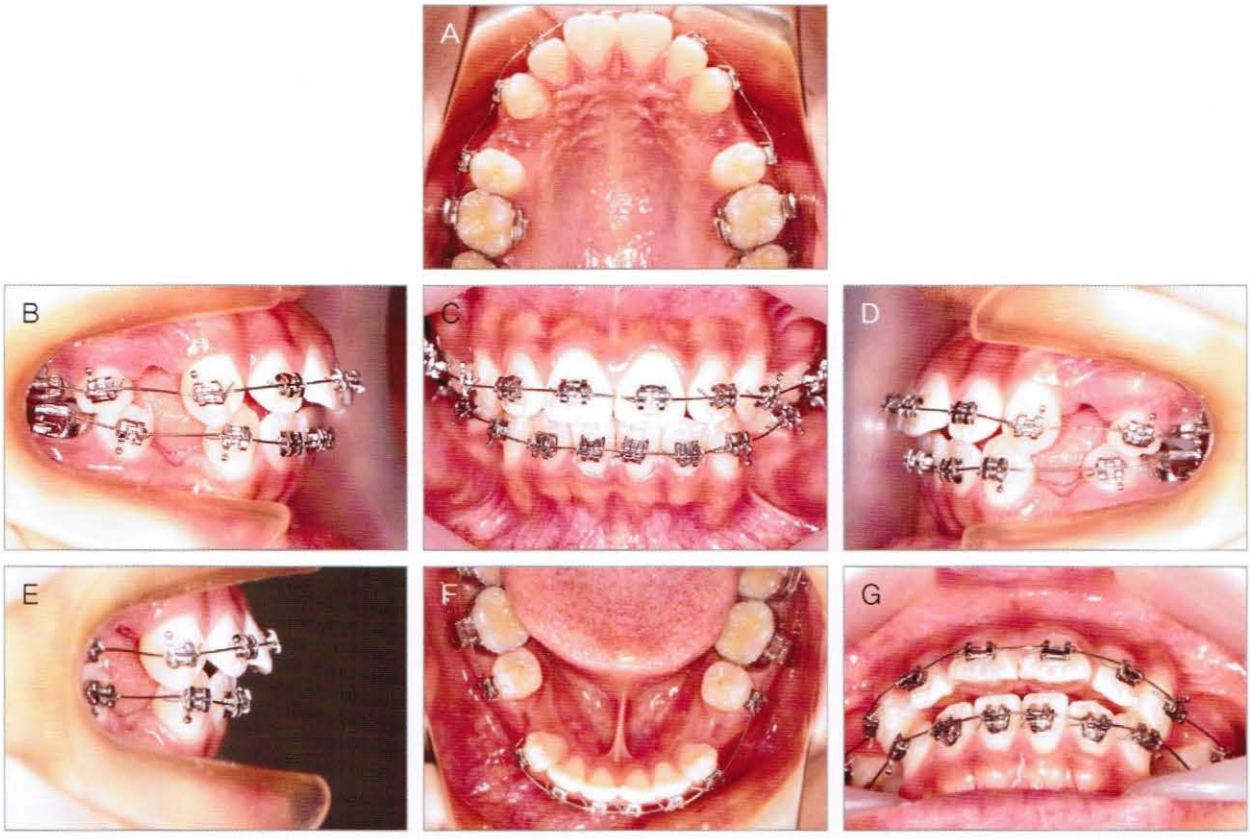


Figure 3-3-7. Leveling stage
Intraoral photograph with 014" NiTi wire inserted (2002. 6.11)

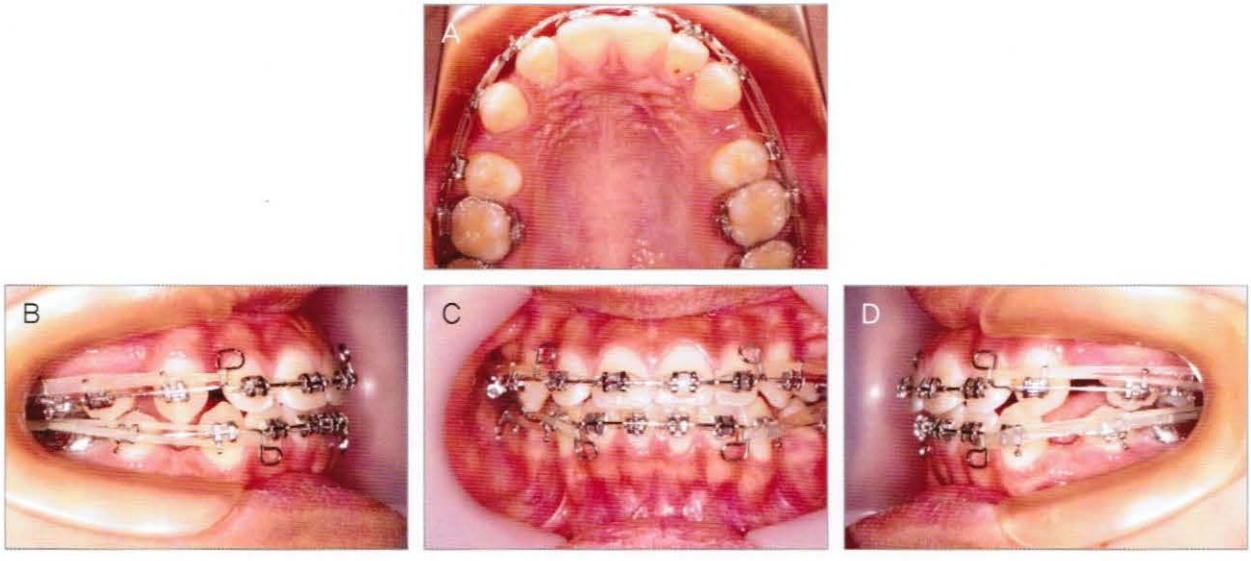


Figure 3-3-8. After leveling up to 016×022" NiTi wire, 018×022" ss shoe hooks are being used to close the extraction space. It was decided to insert mini-implants 1 month later (2002. 9.17).

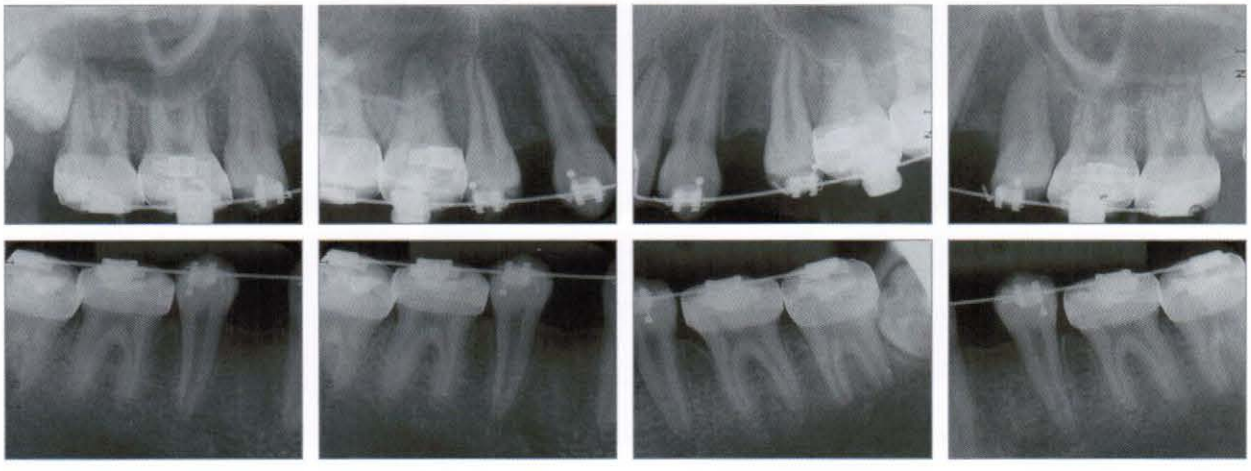


Figure 3-3-9. Periapical radiographs (2002. 10.11)
The space between the second premolars and first molars is relatively wide. It is usually difficult to find good indications in the mandible but in this case, the interradicular spaces are fairly wide.

Clinical tip ››››

When there is lower incisor labioversion with mouth protrusion on a skeletal Class III pattern, anchorage can be reinforced with mini-implants in the molar area.

There are not many other indications for anchorage reinforcement in the lower arch. The lower molars are naturally strong anchor teeth. And with increasing use of mini-implants in the upper arch, the need for Class II elastics has decreased.

Also the interradicular area between the lower second premolar and first molar is narrow, and the failure rate is high due to narrow attached gingiva.

1.6x6.0mm mini-implants were used.

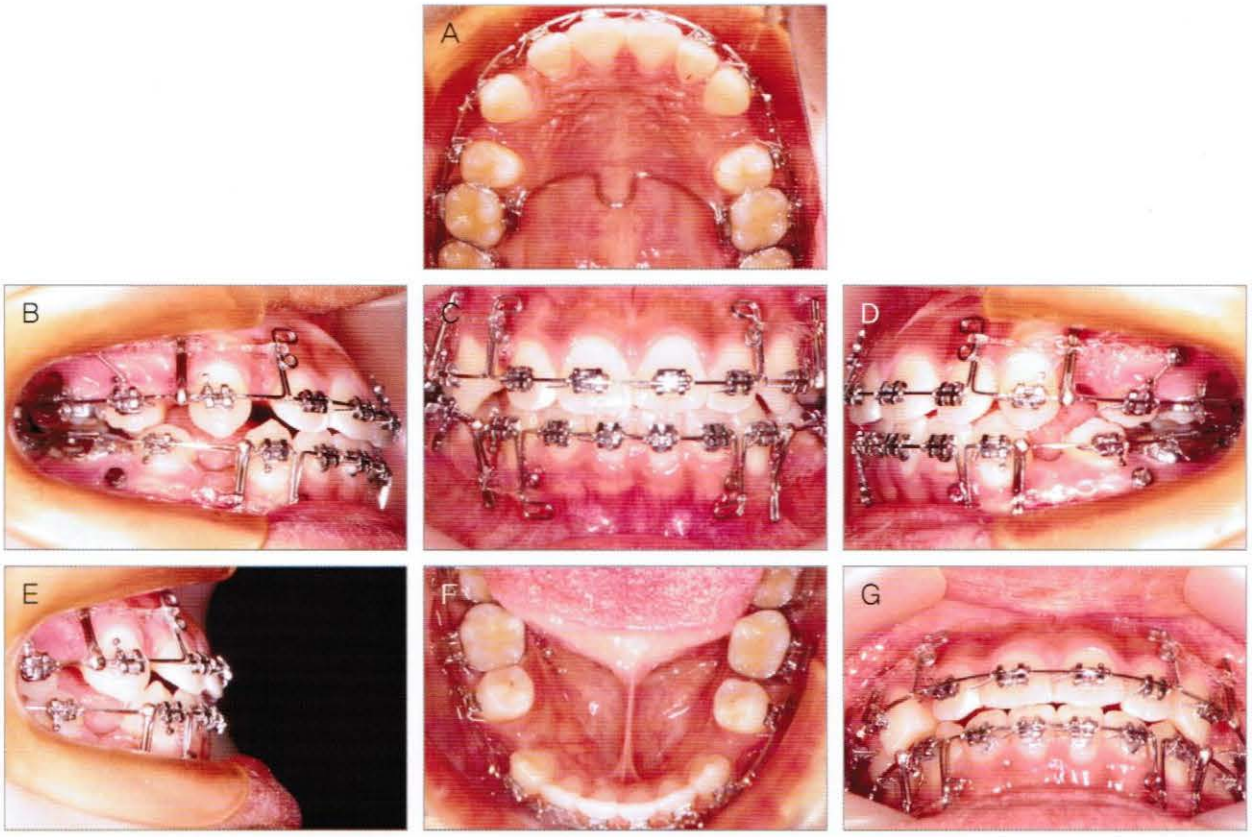
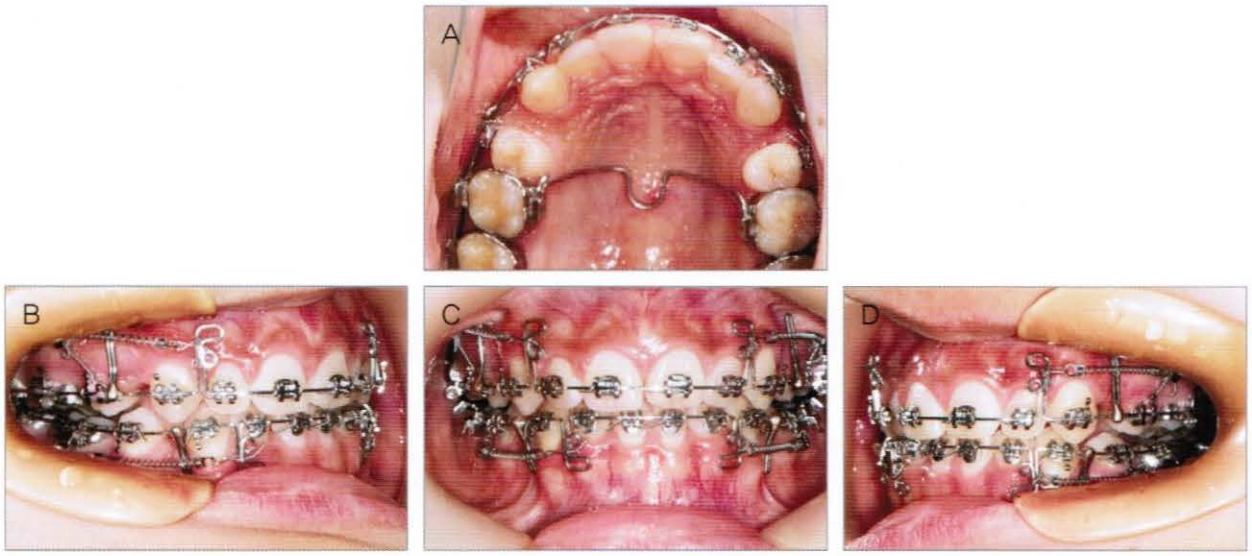


Figure 3-3-10. Space closing stage (2002. 10.25)
019×025" ss wire with long shoe hooks and NiTi coil spring or power chain are being used for space closure in both arches.



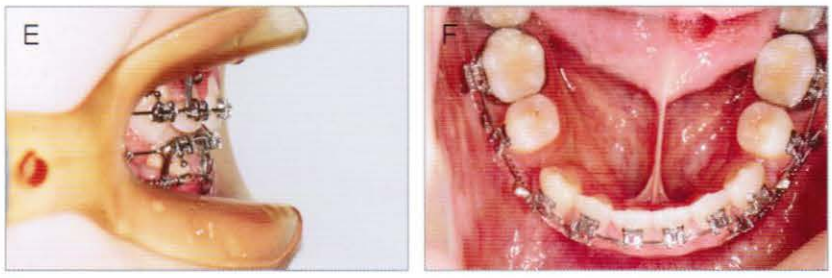


Figure 3-3-11. Space closing stage (2003. 2.28)
Space closure in the upper arch was rapid. However space closure in the lower arch, especially the right side, was solw.

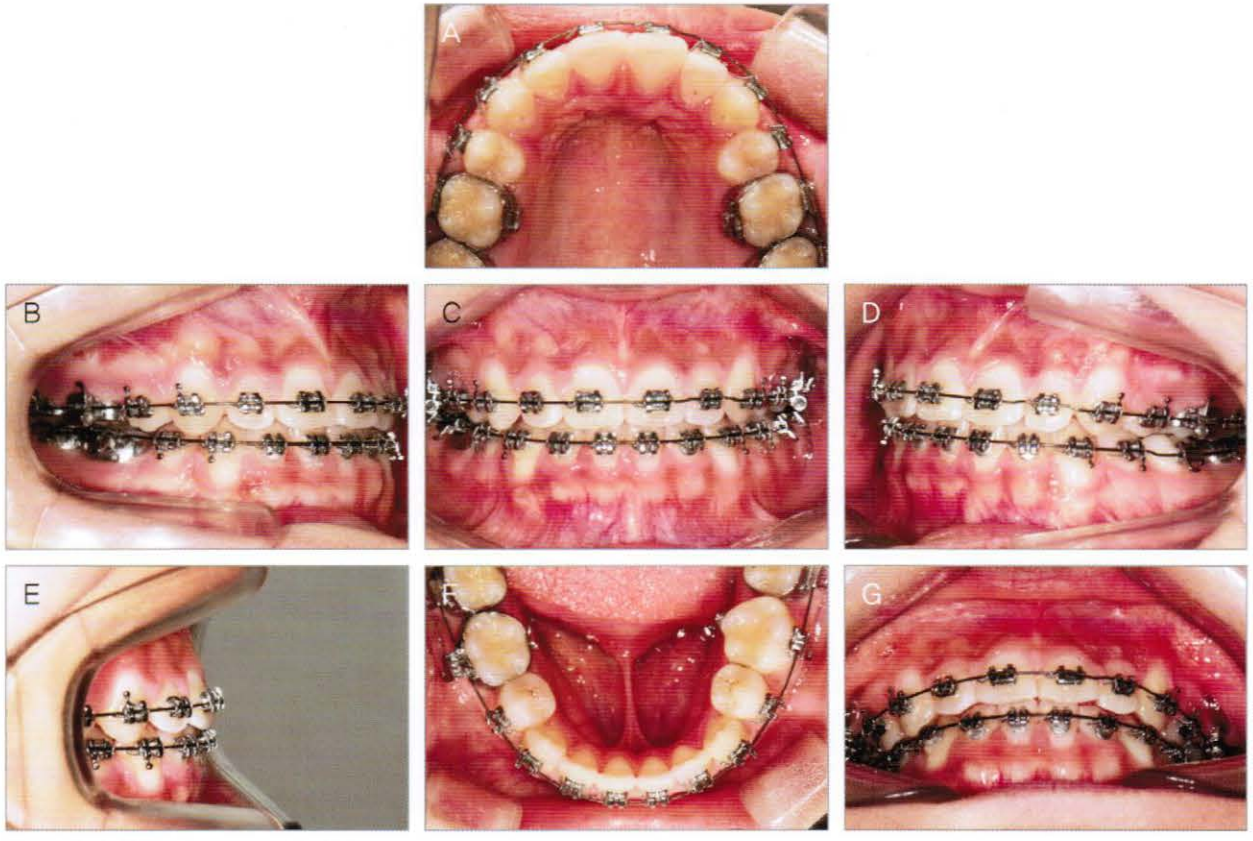


Figure 3-3-12. Detailing stage (2004. 10.30)
After space closure, the lower left first molar bracket was repositioned lower on the tooth, and re-leveled. Note in Figure 3-1-11D how the #36 band position is too close to the occlusal surface. 016" ss wire is in place. Later 018×025" ss wire with shoe hooks were used for further detailing.

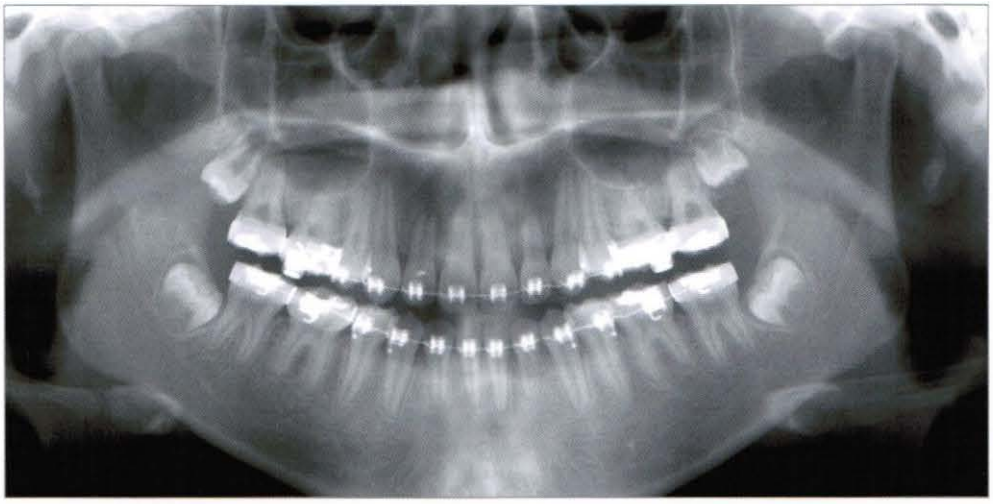


Figure 3-3-13. Panoramic radiograph taken at the detailing stage (2004. 10.30)
Panoramic radiograph is taken at the detailing stage to check for root parallelism and root resorption. The four upper incisors show some apical root resorption.

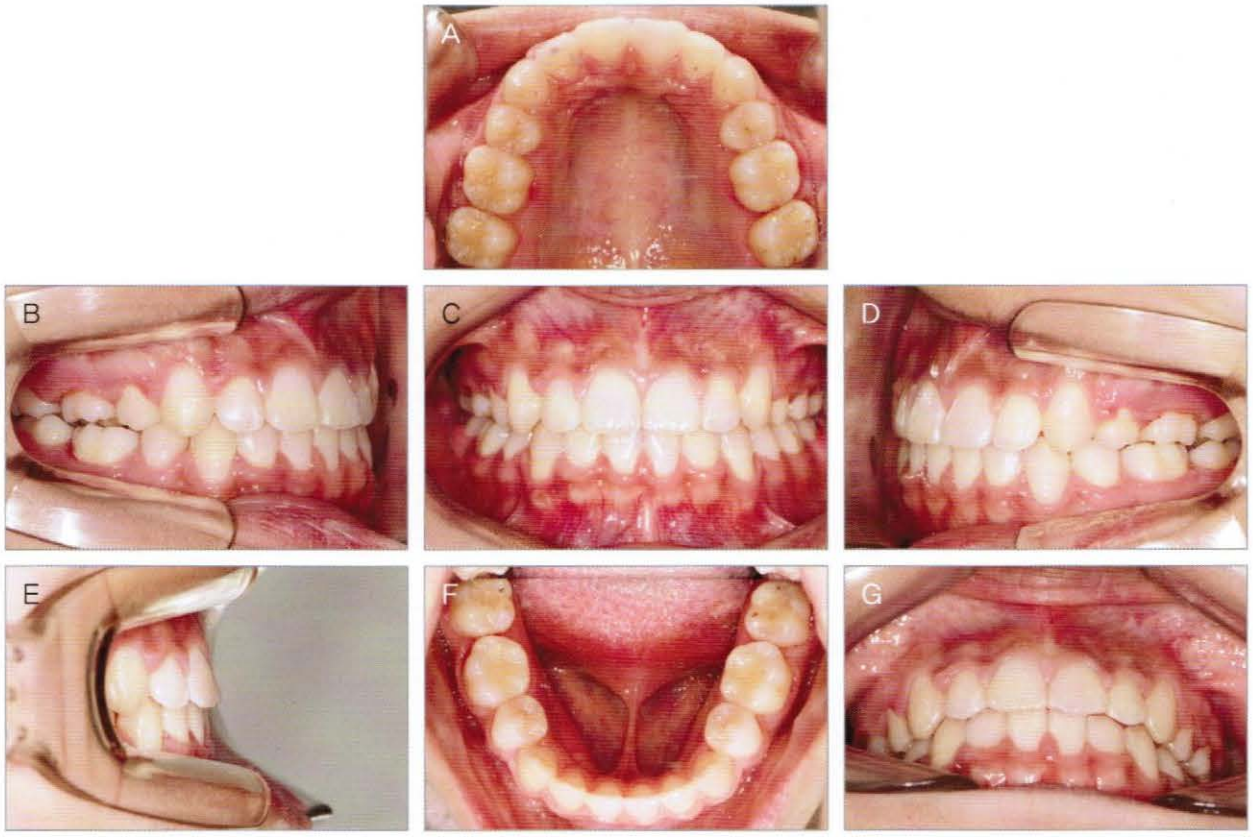


Figure 3-3-14. Intraoral photograph at debonding (2005. 2.3)
Treatment was finished after 32 months of treatment.

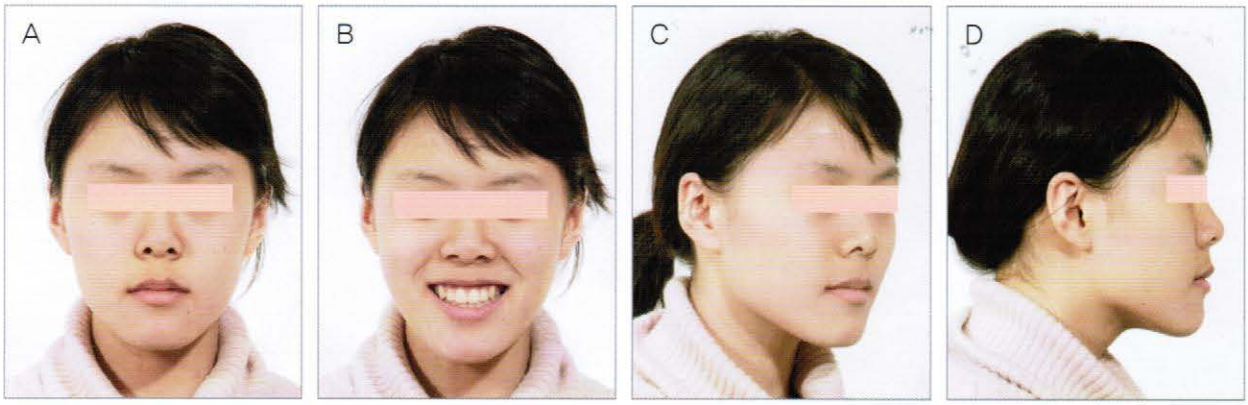
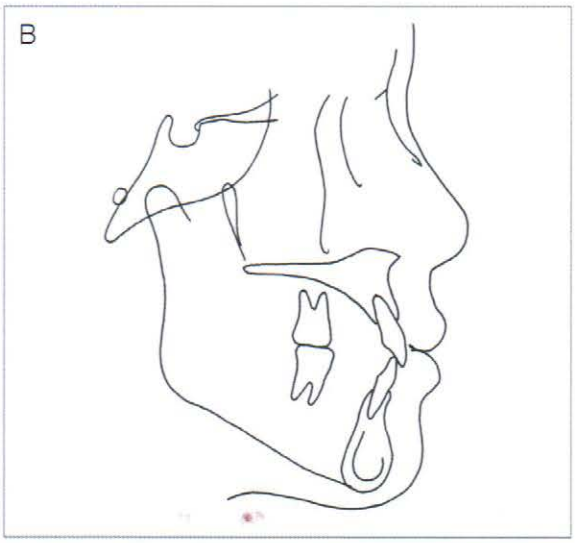
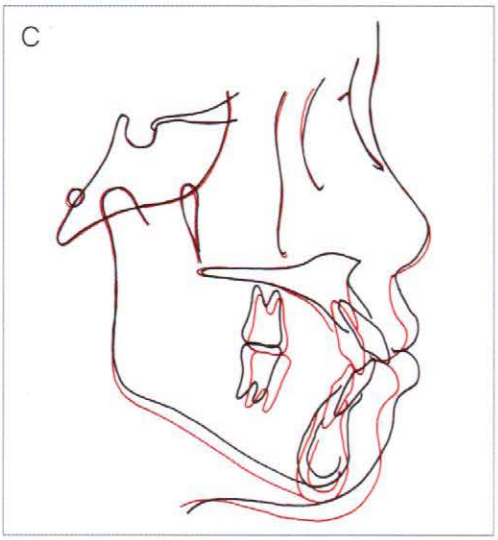


Figure 3-3-15. Facial photograph at debonding (2005. 2.3)
With treatment of mouth protrusion, she shows an esthetic profile. The small nasolabial angle has been normalized. With treatment of mouth protrusion, the nose looks relatively higher.





D

	Norm	T1	T2
SNA	81.6	75.7	76.0
SNB	79.2	76.2	75.5
ANB	2.5	−0.5	0.5
FMA	24.3	27.6	28.2
U1 to FH	116.0	126.8	109.8
IMPA	95.9	95.7	82.6
IIA	123.8	110.0	139.3
Esth-U	−0.9	1.7	−0.7
Esth-L	0.6	5.1	−0.4

Figure 3-3-16. Cephalometric radiograph and measurement at debonding
A. Profile improvement shown on cephalometric radiograph. B. Cephalometric measurement and tracing at debonding.
C, D. Superimposition of pre- and post-treatment.
The upper incisors have been retracted a fair amount. There has been some mandible growth. The relative amount of retraction required for treatment of mouth protrusion has decreased. Some mesial movement of molars has been allowed.

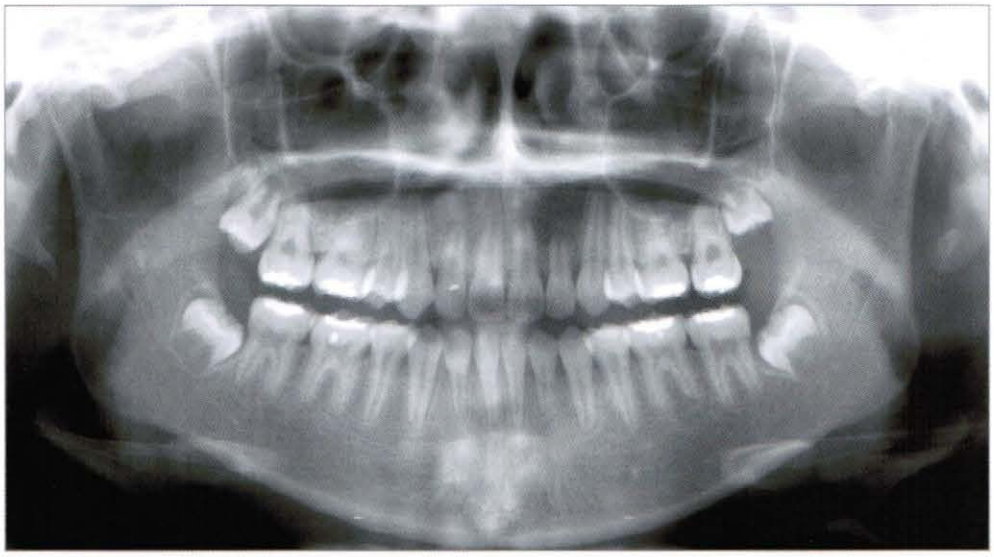
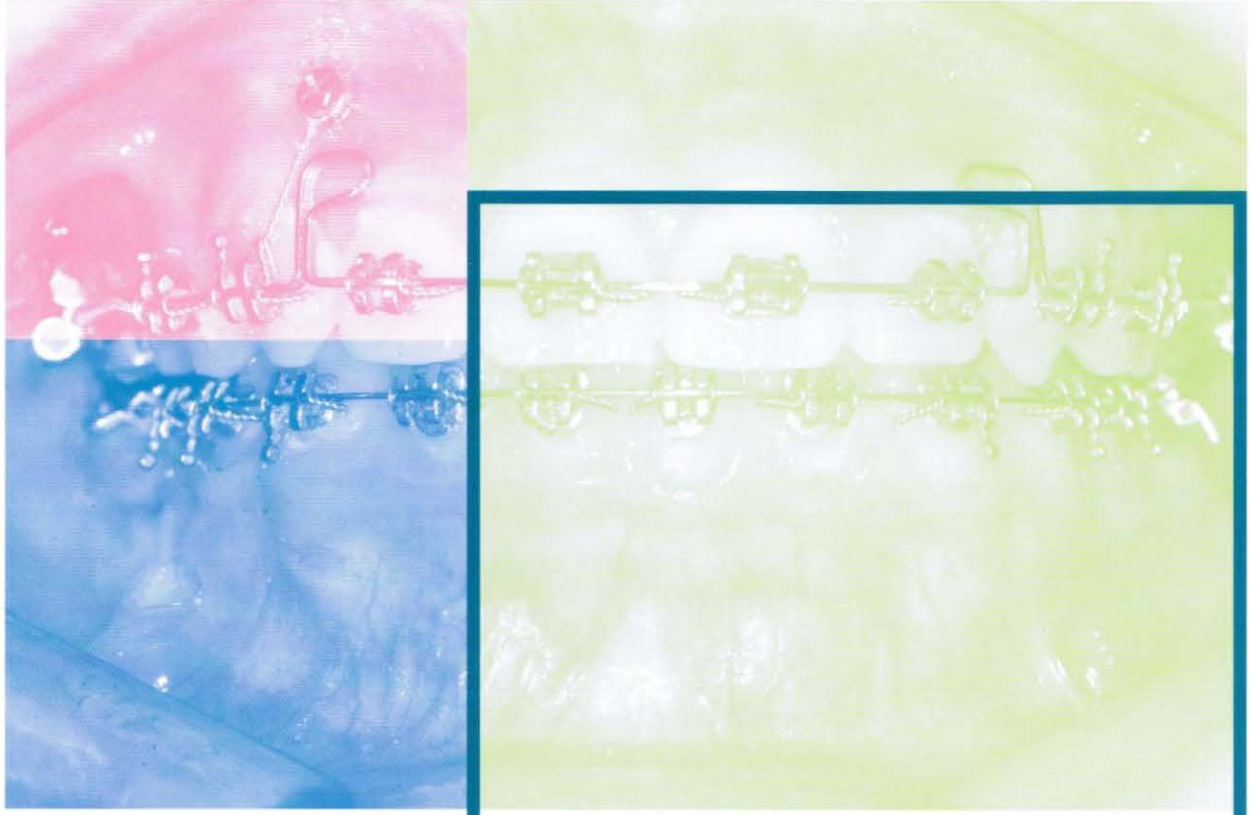


Figure 3-3-17. Panoramic radiograph at debonding



Chapter 4

Reinforcement of anterior anchorage

Chapter 4 Reinforcement of anterior anchorage

The need for reinforced anterior anchorage includes such cases as dished-in-face (mouth looks sunken in) and spacing. Treatment sequence will be presented using clinical cases.

I . Protraction of upper molars

When posterior molars require mesial movement, mini-implants can be inserted in the anterior region for anchorage reinforcement. We will examine 2 cases.

■ Case 4 (Figure 4-1-1 to 16)

- Age : 18 years 4 months
- Sex : female
- Chief complaint : upper anterior crowding, one protruded upper central incisor

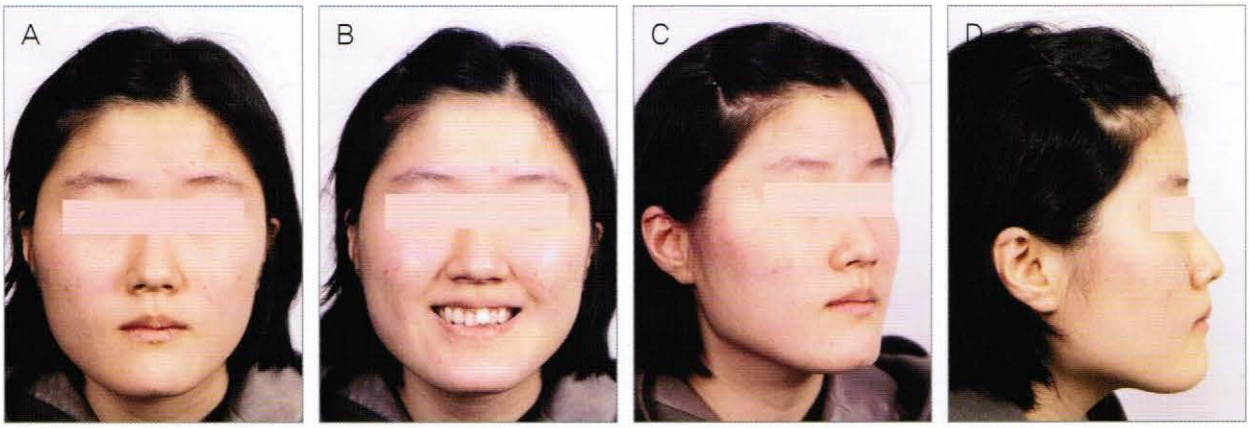
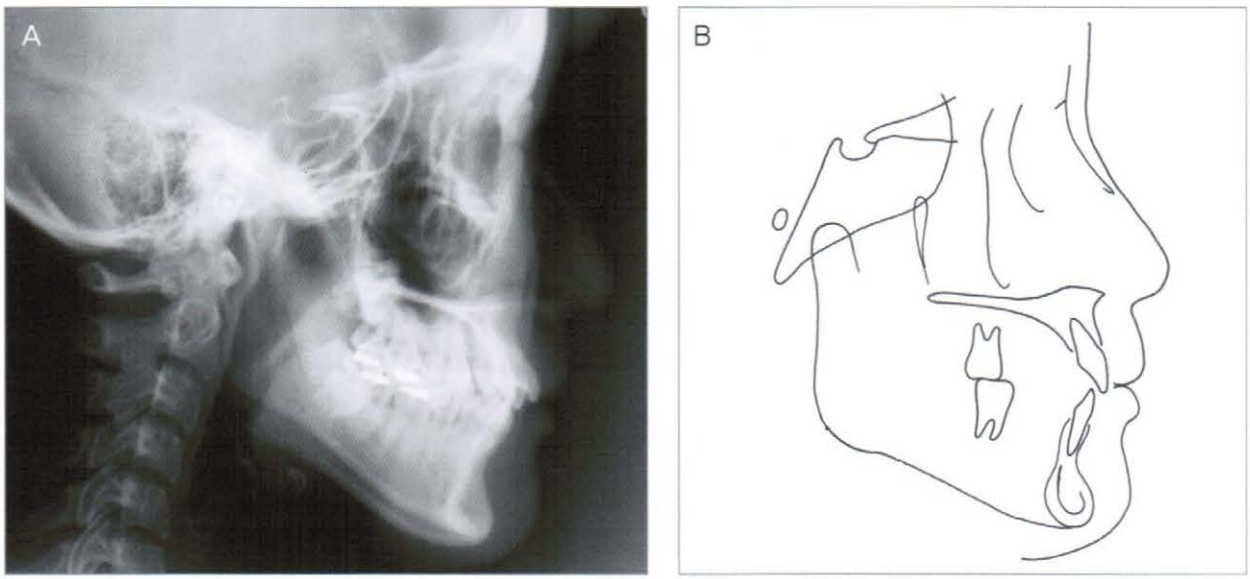


Figure 4-1-1. Pre-treatment facial photograph of Case 4
She has difficulty with mouth closure due to the protruded left central incisor. Because the photograph was taken with the upper lip tensed, it actually looks retruded. This is the reason why facial photographs should be taken with the lips at rest.

Figure 4-1-2. Intraoral photograph of Case 4
There is crowding in both arches (A, F). The lower midline is deviated slightly to the right. The left canine and first molars seem to be in a Class I relationship (B, D). The upper left central incisor shows severe labioversion (G).



C

	Norm	SD	T1
SNA	81.6	3.2	83.0
SNB	79.2	3.0	78.5
ANB	2.5	1.8	4.5
FMA	24.3	4.6	25.0
U1 to FH	116.0	5.8	111.5
IMPA	95.9	6.4	86.0
IIA	123.8	8.3	136.5
Esth-U	-0.9	2.2	-3.5
Esth-L	0.6	2.3	-3.0

Figure 4-1-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. She shows good facial profile. Because the nose is high and the chin well developed, the lips look relatively sunken in.
B, C. The skeletal antero-posterior relationship can be said to be Class I. With the upper left central incisor as a reference, the upper incisor shows labioversion, but with the upper right central incisor as a reference, U1 to FH at 111.5° and IMPA at 86.0° shows that upper and lower incisors are lingually inclined. The interincisal angle (136.5°) is larger than normal.

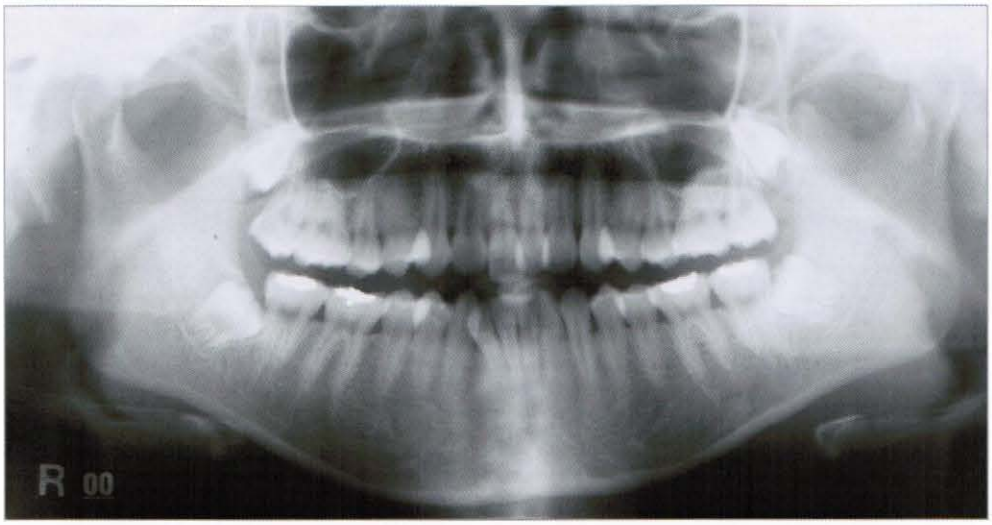


Figure 4-1-4. Pre-treatment panoramic radiograph
All the third molars are present, and the lower third molars are horizontally impacted.

〈Treatment sequence〉

Upper and lower first premolars were extracted prior to orthodontic treatment. The advantages and disadvantages of non-extraction, first premolar and second premolar extraction were compared. In this case, non-extraction or second premolar extraction would be a better option. This case may be of help in situations where difficulties in space closure after first premolar extraction are being met.

To prevent excessive lip retraction, mini-implants were inserted between the lateral incisor and canine to reinforce anterior anchorage.

Treatment Progress

■ Leveling		11 months
– 2001. 7.18	014″ NiTi	
– 2001. 8.21	018″ NiTi	
– 2001. 9.19	016×022″ NiTi	
– 2001. 10.12	016×022″ ss + open coils	
– 2001. 12.7	014″ NiTi	
– 2002. 1.25	016″ NiTi	
– 2002. 3.6	016×022″ NiTi	
– 2002. 4.10	018×022″ ss with shoe hooks	
■ Implantation		
– 2002. 6.20	1.6×6.0 2EA 3↓2|2↓3	
■ Space closing		9 months
– 2002. 6.27	U : Class I elastics 5/16″ 6oz Class II elastics 5/16″ 6oz	
■ Detailing		5 months
– 2003. 3.21	Bracket repositioning L : 018″ NiTi	
– 2003. 4.25	L : 016×022″ NiTi	
– 2003. 6.10	L : 018×022″ ss with shoe hooks	
■ Debonding		
– 2003. 8.5		Total 25 months

Clinical tip ››››

Non-extraction or extraction?
Distal driving or not?
Extraction of the first premolars or the second premolars?

In a case such as this, these questions must be asked. If the first premolars are extracted, there is risk of a dished-in appearance, and with non-extraction, the risk of finishing treatment with mouth protrusion. Also crowding of the lower incisors may relapse. In these cases second premolar extractions may be the answer. Disadvantages of second premolar extraction are that relief of crowding may take longer. Distal driving with non-extraction can be attempted. However all the third molars are impacted, and posterior space is lacking. And because the crown of the upper right second molar is inclined distally, distal driving will be difficult.

Therefore in cases such as these, second premolar extraction may be the answer. After correction of crowding, anterior anchorage may be reinforced with mini-implants to close the rest of the extraction space through mesial loss of molars. This will prevent excessive incisor retraction and a dished-in profile.

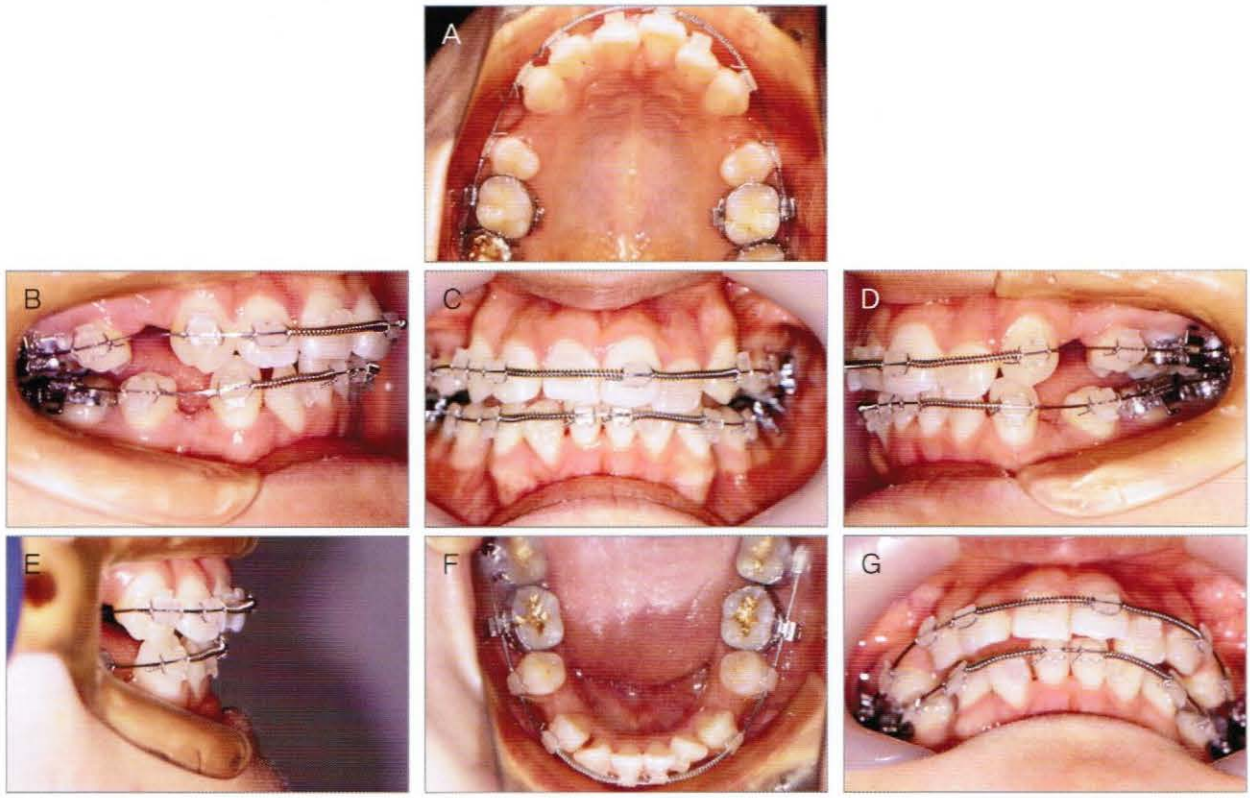


Figure 4-1-5. First stage of leveling
After sequential leveling with 014″ NiTi, 018″ NiTi, and 016×022″ NiTi wire, 016×022″ ss + open coil spring is being used for canine retraction and space provision for incisor alignment (2001. 10.12)

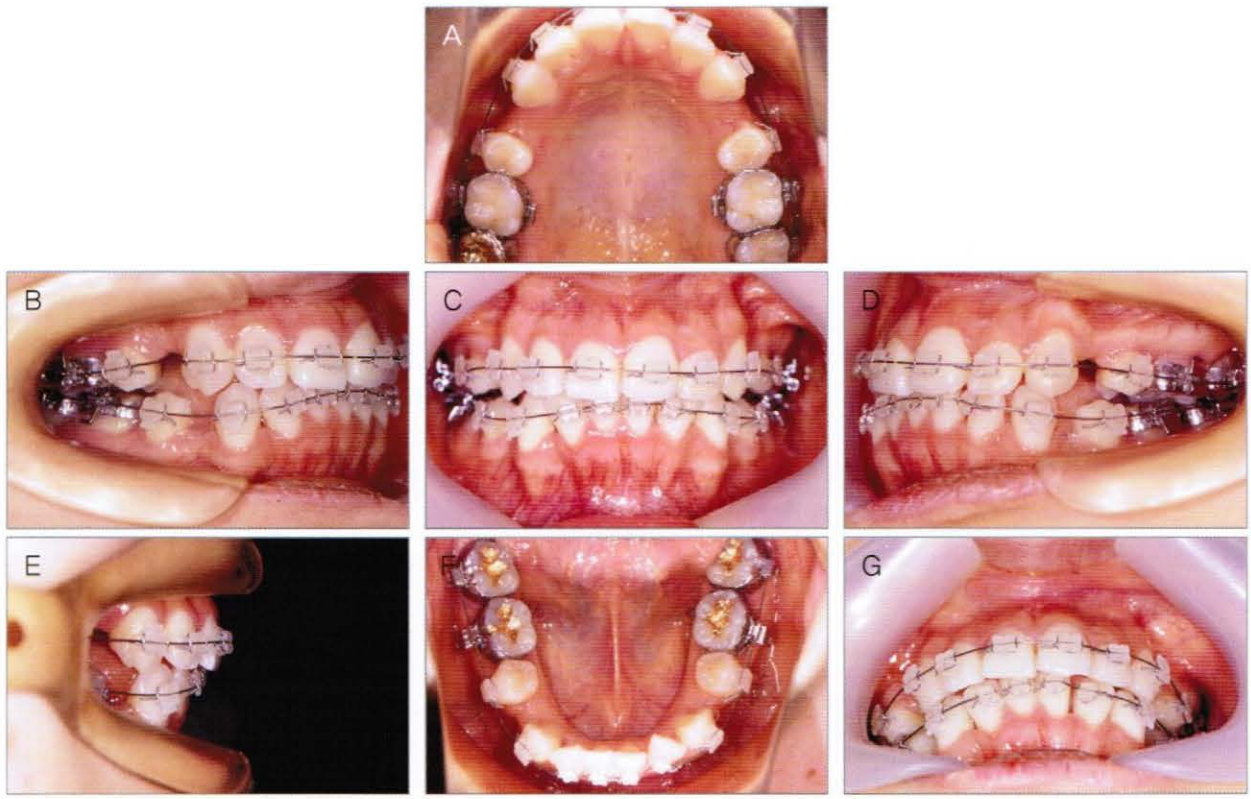


Figure 4-1-6. Second stage of leveling (2001. 12.7)
After space opening for alignment of crowded teeth at the first leveling stage (Figure 4-1-5), 014″ NiTi is being used for re-leveling.

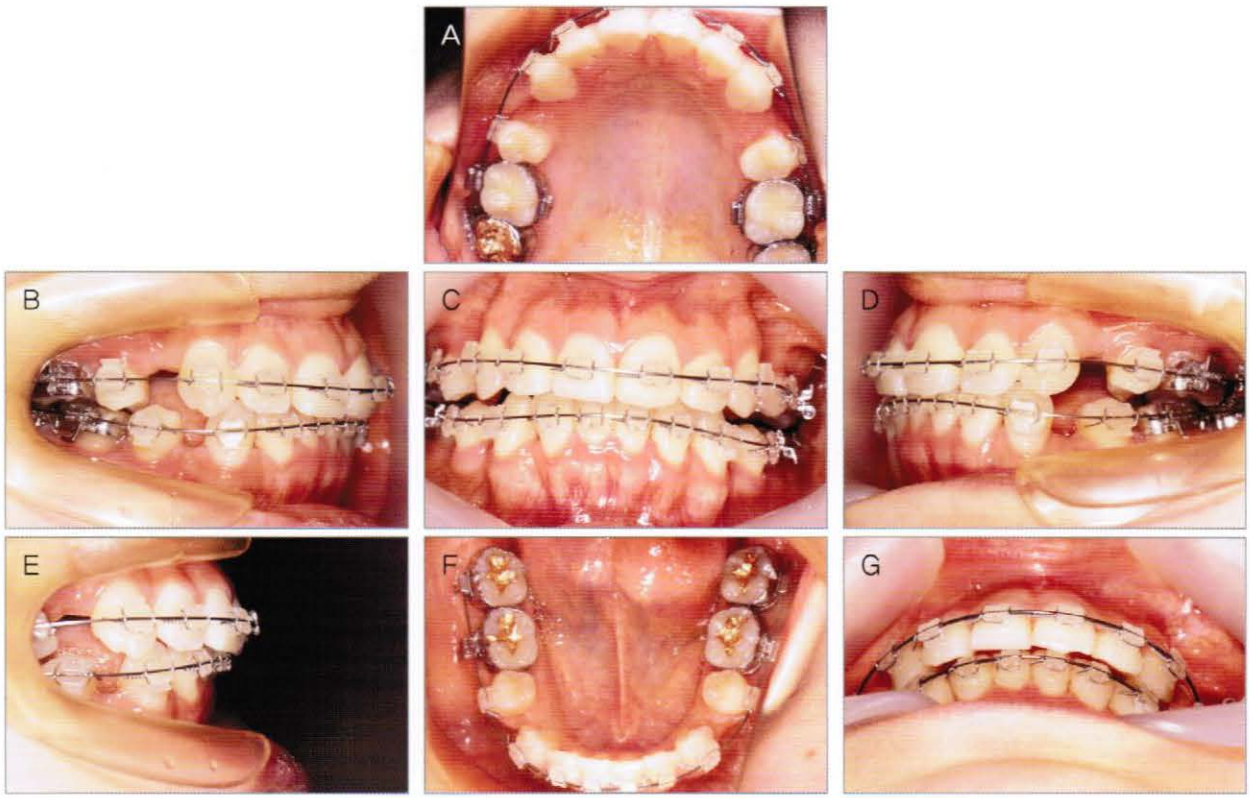


Figure 4-1-7. Continuation of second stage of leveling (2002. 3.6)
016×022″ NiTi is inserted.

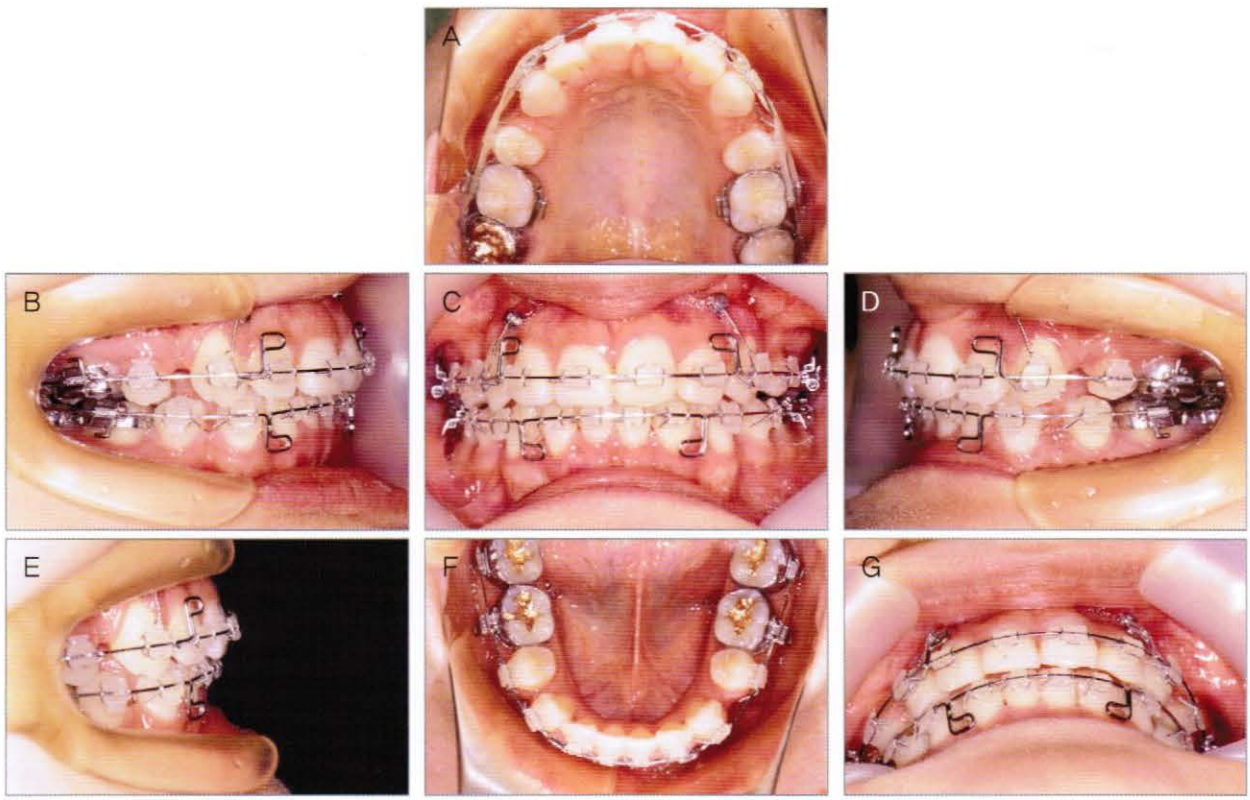


Figure 4-18. Mini-implant insertion (2002. 6.20)
1.6×6.0mm mini-implants are inserted between the upper lateral incisor and canine. The mini-implant head and canine bracket is tightly ligated with 010″ steel ligature wire to prevent distal movement of the canines. 018×022″ ss with shoe hooks have been inserted in both arches.

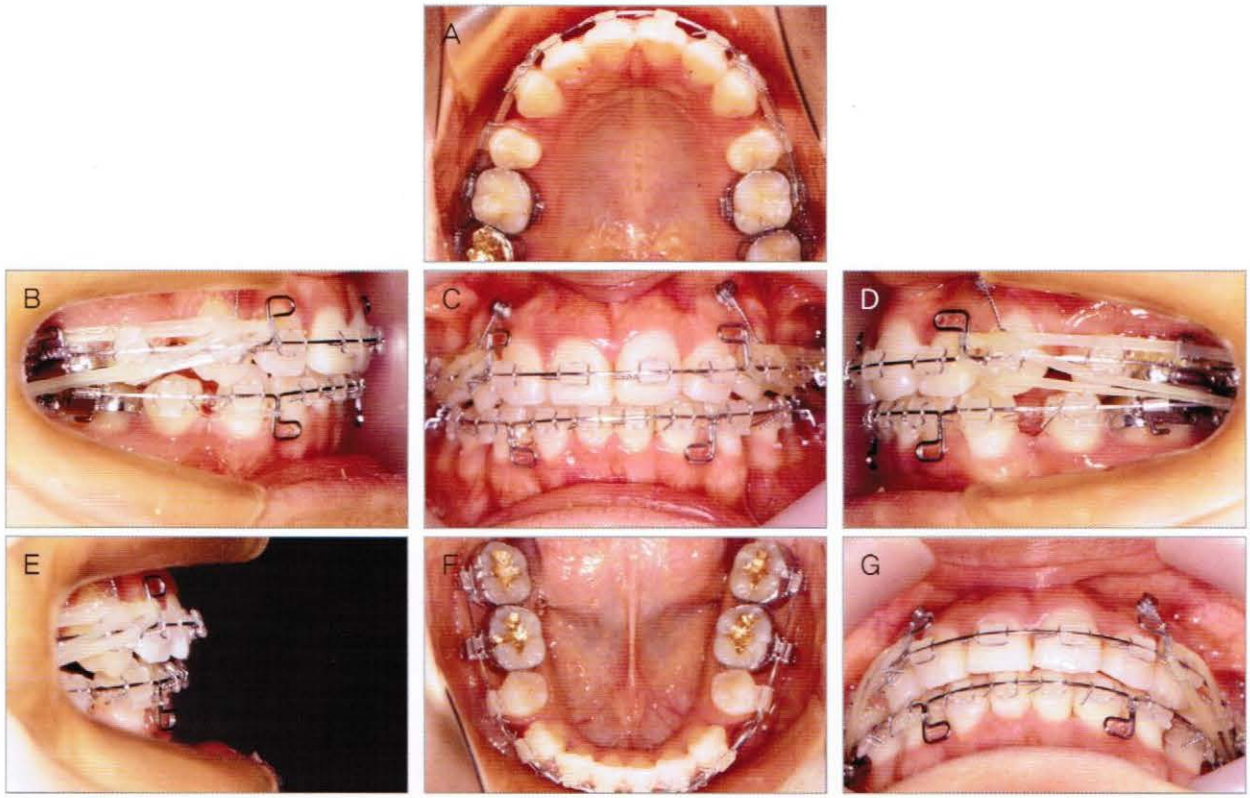


Figure 4-1-9. Protraction of posterior teeth (2002. 6.27)
5/16" 6 oz Class II elastics, and 5/16" 6 oz Class I elastics in the upper arch are being used.

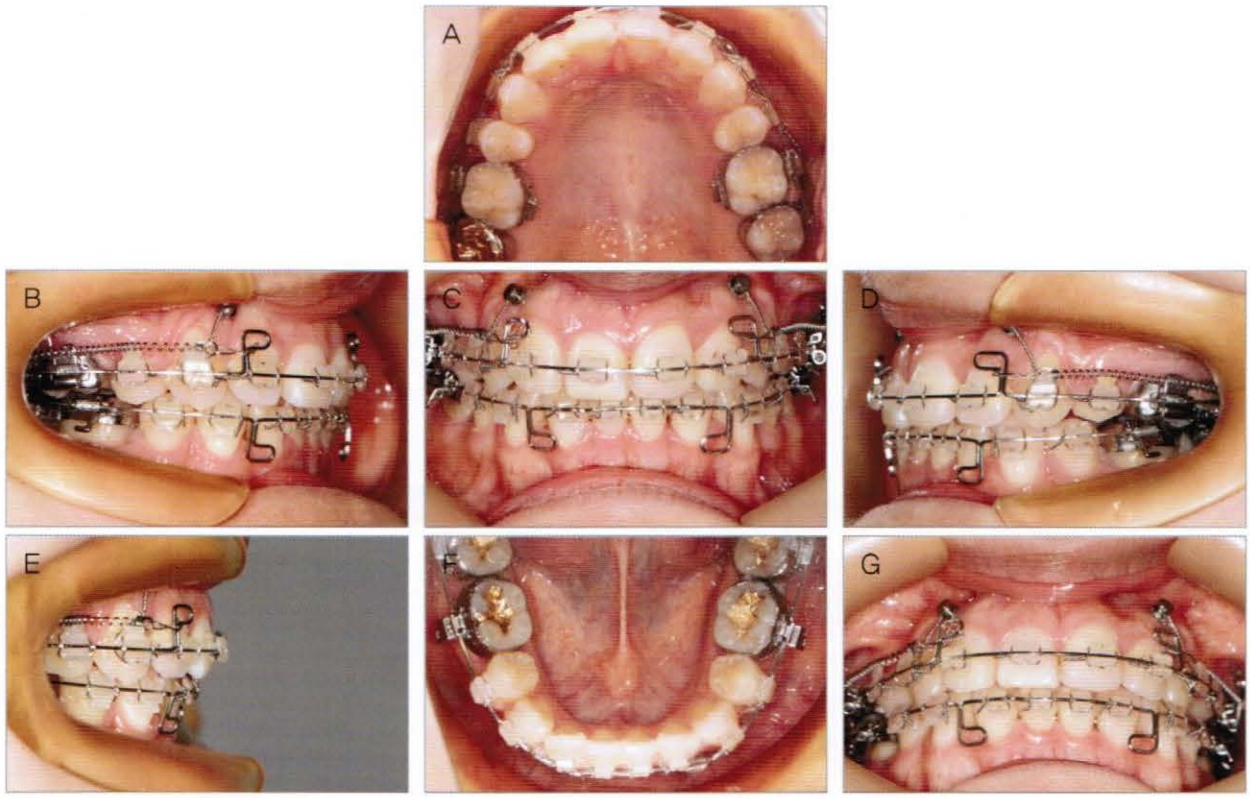
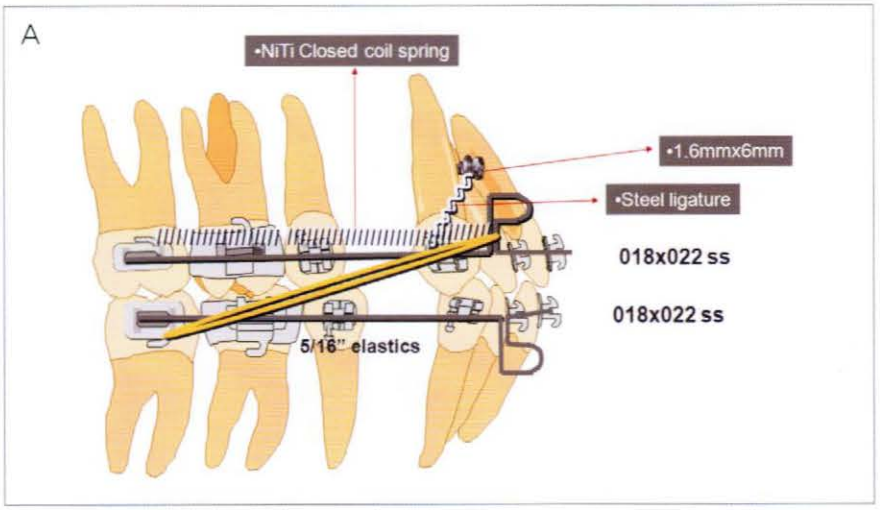
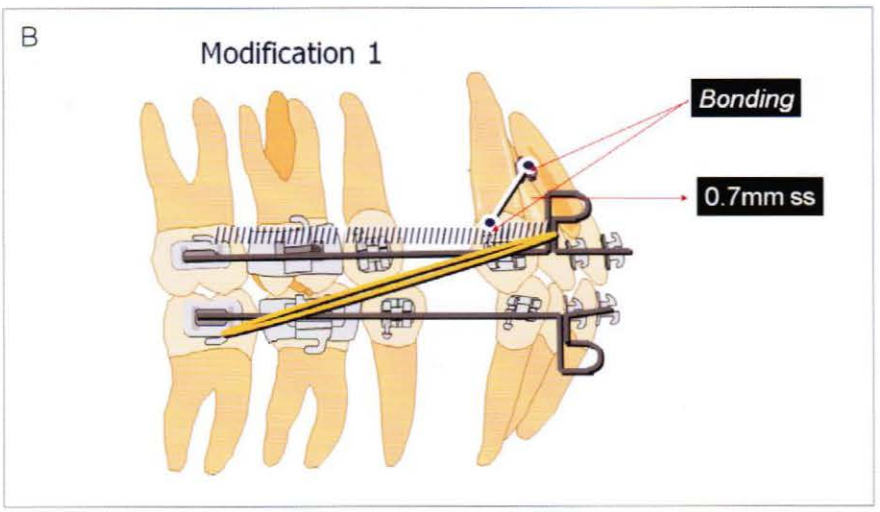


Figure 4-1-10. Completion of molar protraction (2003. 3.21)
NiTi closed coil spring is used instead of upper Class I elastics. All the spaces are closed.

〈Methods of mesial molar protraction〉





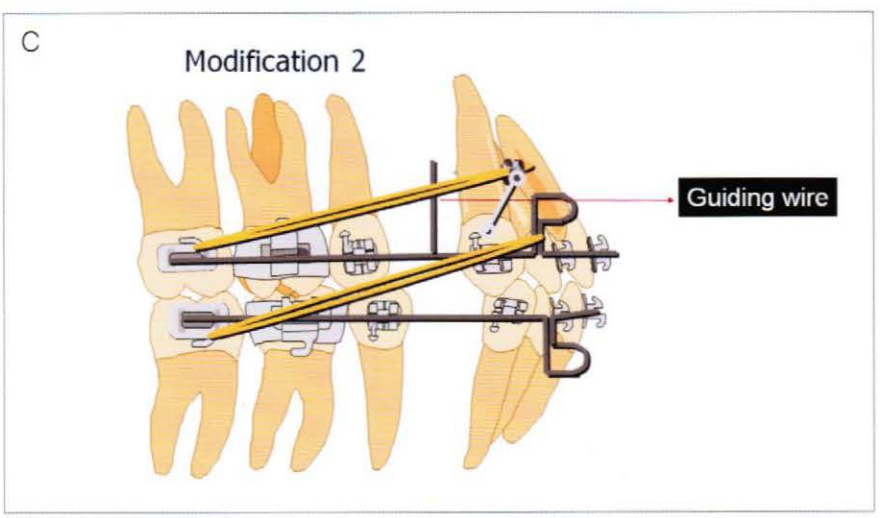


Figure 4-1-11. Methods of mesial molar protraction
A. Ligating with ligature wire
It is very simple. Ligature wire can be removed at any time to allow movement of the canine and lateral incisor. However there are possibilities that some retraction of the incisors will occur.
B. Modification 1 : bonding of 0.7mm wire segment from the labial surface of the canine to mini-implant head.
Protraction force is provided through NiTi closed coil spring between the second molar and shoe hook. Class II 5/16" 6 oz elastics are used for lower molar protraction.
C. Modification 2 : bonding of 0.7mm wire segment from the labial surface of the canine to mini-implant head.
5/16" 6 oz elastics are hooked from the mini-implant head to the second molar. 0.9mm wire is soldered as a guiding wire to prevent gingival impingement from elastics.
If the interradicular space between the lower incisors is wide enough, mini-implants can be inserted here for molar protraction forward. The above mechanics is planned to allow use of the minimum number of mini-implants.

Clinical tip ››››

Why are mini-implants inserted between the lateral incisor and canine?

When Roth set-up or MBT is used, the canine root tip inclines distally. Therefore the space distal to the canine root is too narrow for mini-implant insertion. However the space mesial to the canine root becomes wider, and safe implantation is possible.

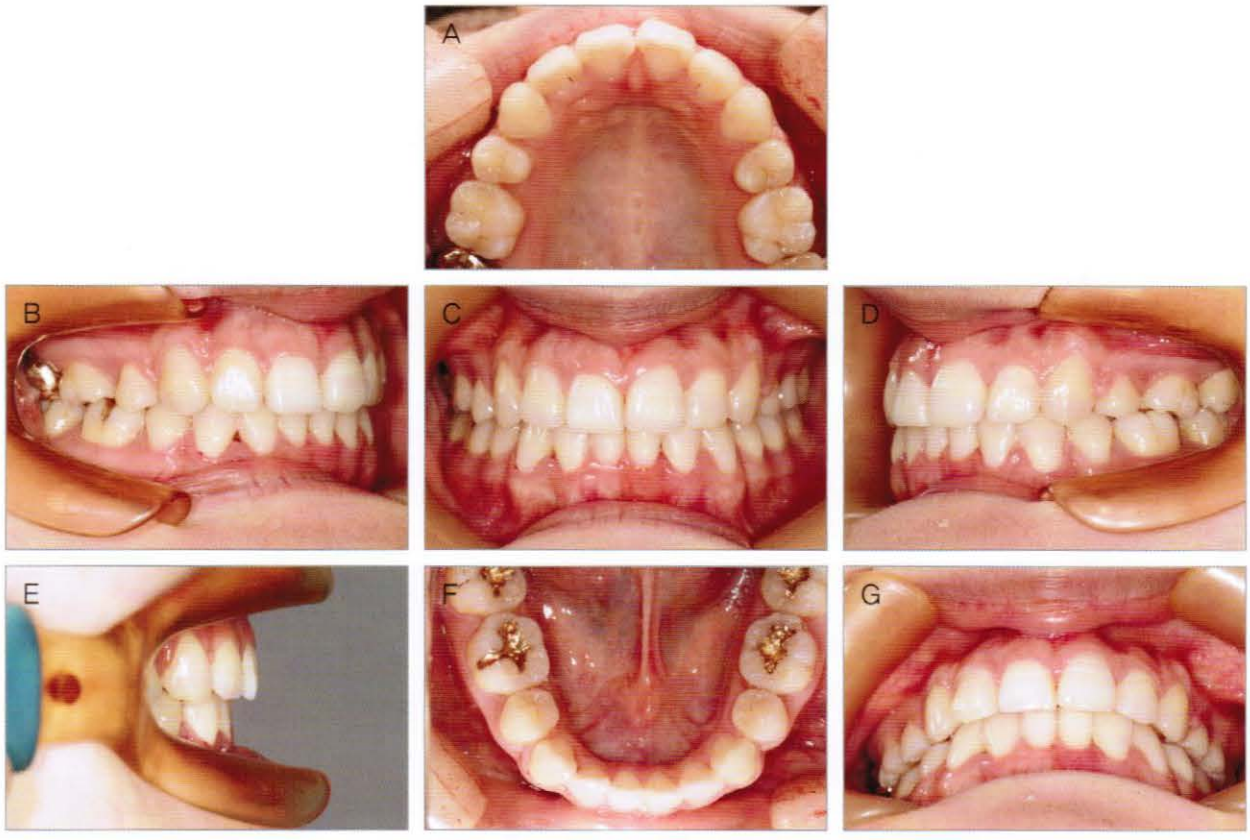


Figure 4-1-12. Intraoral photographs at debonding (2003. 8.5)

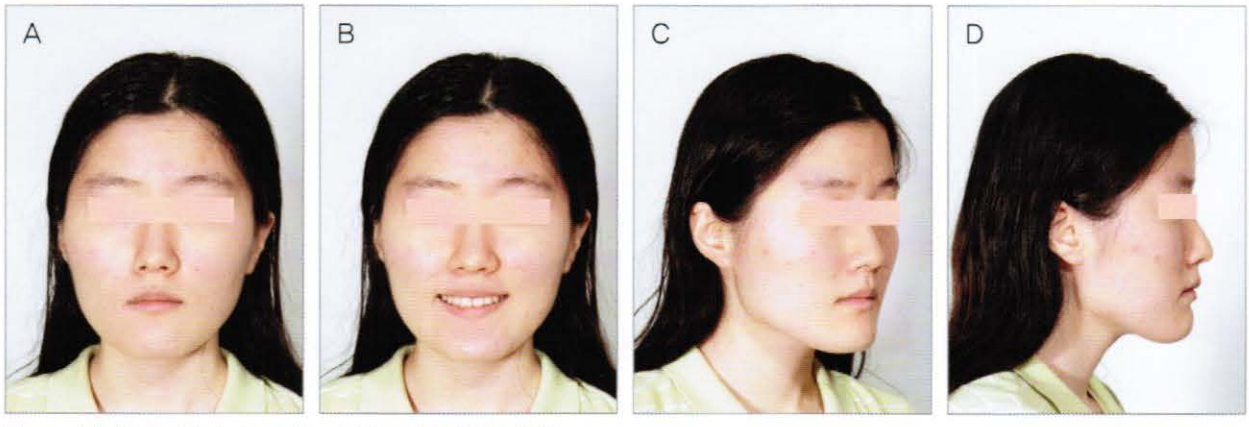
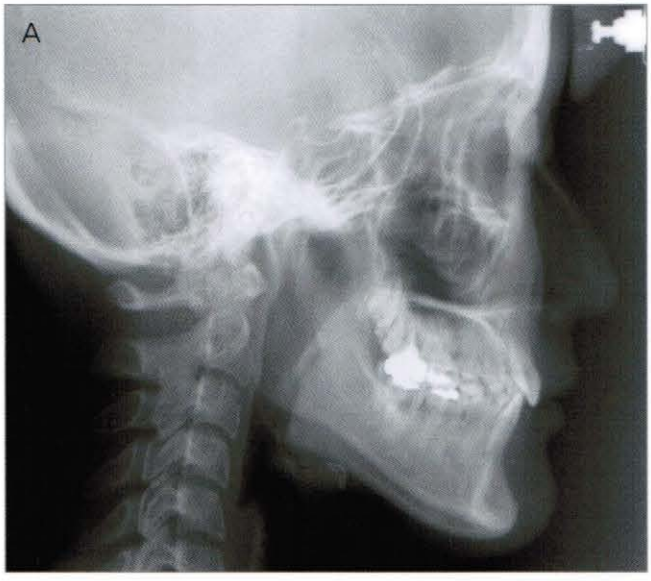
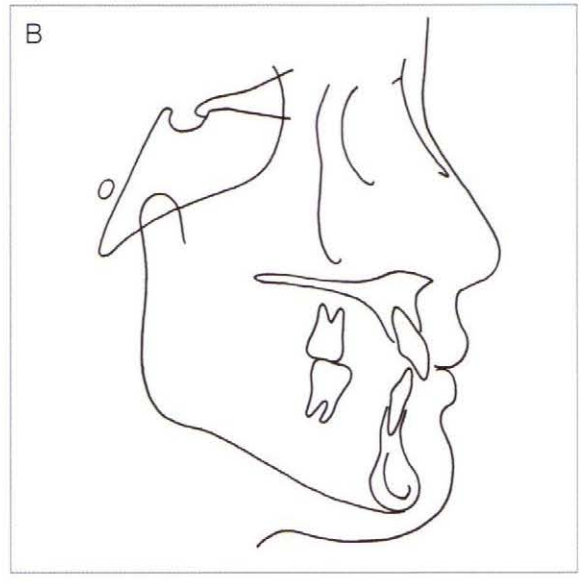
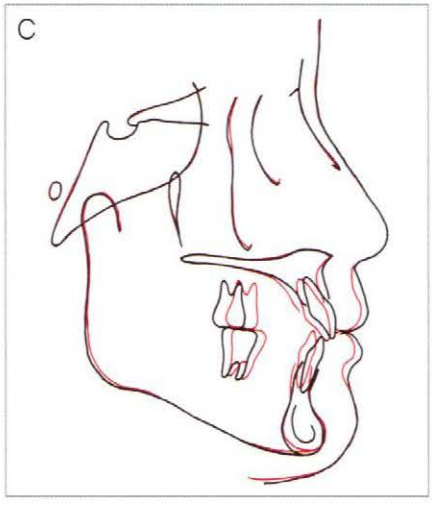
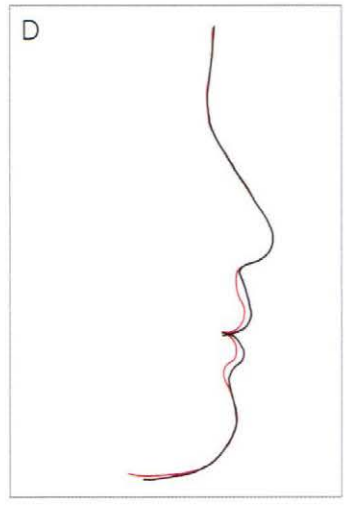


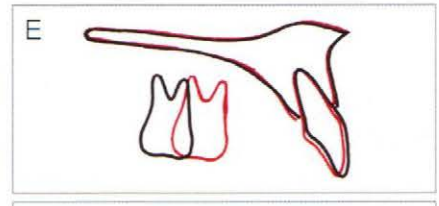
Figure 4-1-13. Facial photographs at debonding (2003. 8.5)
A. The mouth closing muscles are not strained during closing.
C, D. The lips are receded, but she does not show an excessive dished-in appearance.

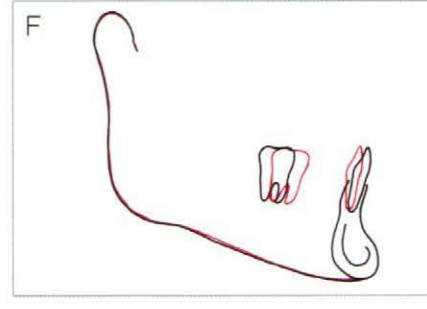








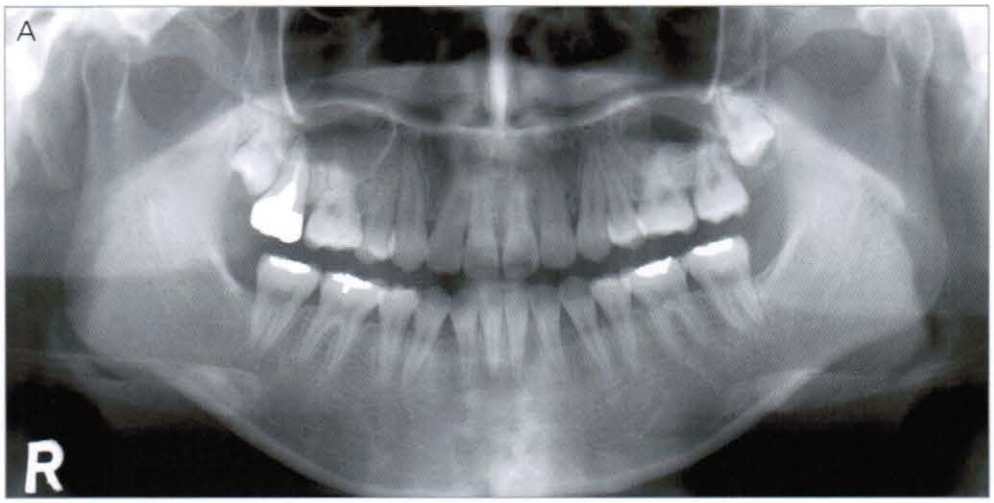




G

	Norm	T1	T2
SNA	81.6	83.0	81.5
SNB	79.2	78.5	79.0
ANB	2.5	4.5	2.5
FMA	24.3	25.0	21.0
U1 to FH	116.0	111.5	112.0
IMPA	95.9	86.0	87.0
IIA	123.8	136.5	139.6
Esth-U	-0.9	-3.5	-3.7
Esth-L	0.6	-3.0	-3.7

Figure 4-1-14. Cephalometric radiograph and measurement at debonding
A. Post-treatment cephalometric radiograph
B. Post-treatment cephalometric tracing
C. Pre-and post-treatment superimposition
D. Pre-and post-treatment superimposition of facial profile. The lips have been slightly retracted, but the reinforcement of anterior anchorage with mini-implants has prevented excessive retraction of incisors.
E. Pre-and post-treatment superimposition of tooth movement with the upper palatal plane and ANS as reference. It shows mainly anterior movement of the first molars.
F. Pre-and post-treatment superimposition of tooth movement with Xi-Pm line and PM point as reference. The lower molars also show mesial movement.
G. Cephalometric analysis. T1 shows pre-treatment and T2 post-treatment.



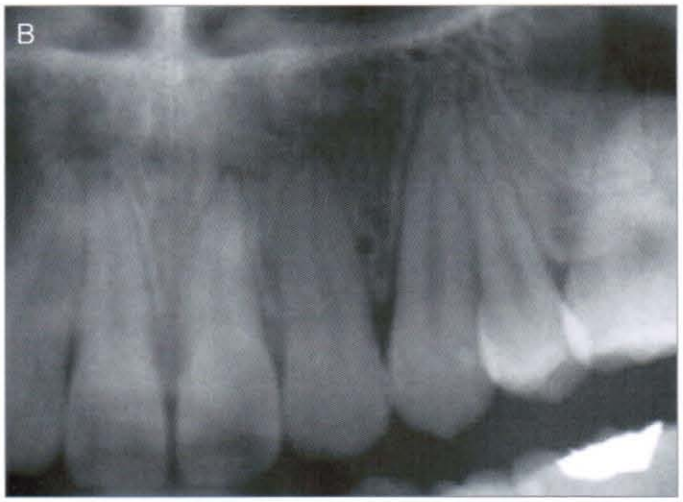


Figure 4-1-15.
A. Panoramic radiograph at debonding.
B. There is evidence that the mini-implant has invaded the periodontal ligament space. Fortunately it caused no problems as movement of the anterior teeth was not planned.

Clinical tip ››››

Root and periodontal ligament damage due to mini-implant

There have been reports of the need to carry out endodontic treatment due to root damage. When the mini-implant touches the root, it will slip away from the root due to its smooth surface. If high resistance is felt during insertion, excessive force should not be exerted. The angle of insertion should be varied and the possibility of root contact confirmed. Also, when the mini-implant touches the root surface, there is higher risk of failure.

It is recommended that a stent be used when inserting in the posterior buccal area to prevent possible root damage. In other areas, only insert in areas where the space between roots is wide enough.

Take a periapical radiograph after mini-implant insertion to check for root contact. If contact has occurred, remove immediately and re-insert to decrease the chances of root damage.

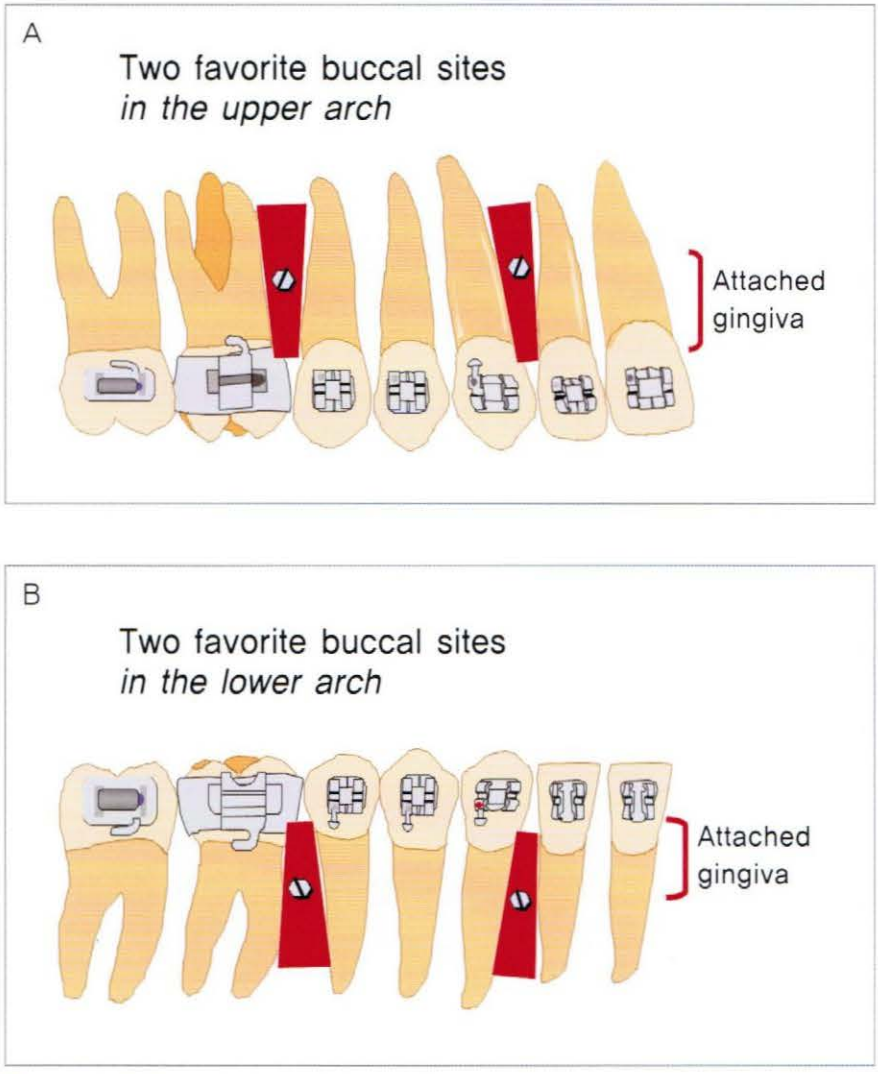


Figure 4-1-16. Preferred site for mini-implant insertion

A. Upper buccal and labial. The space between the lateral incisor and canine or between the second premolar and first molar are the widest after leveling. Insert in the highest point of the attached gingiva.

B. Lower buccal and labial. The space between the lateral incisor and canine or between the second premolar and first molar are the widest after leveling. Insert in the lowest point of the attached gingiva. The attached gingiva in the mandible is fairly narrow, so finding good indications for mini-implant insertion is difficult.

Ⅱ. Protraction of lower molars

When protraction of lower molars are planned, mini-implant can be inserted in the anterior region for anchorage reinforcement.

■ Case 5 (Figure 4-2-1 to 4-2-29)

- Age : 23 years 1 month
- Sex : male
- Chief complaint : mandible protrusion, spacing

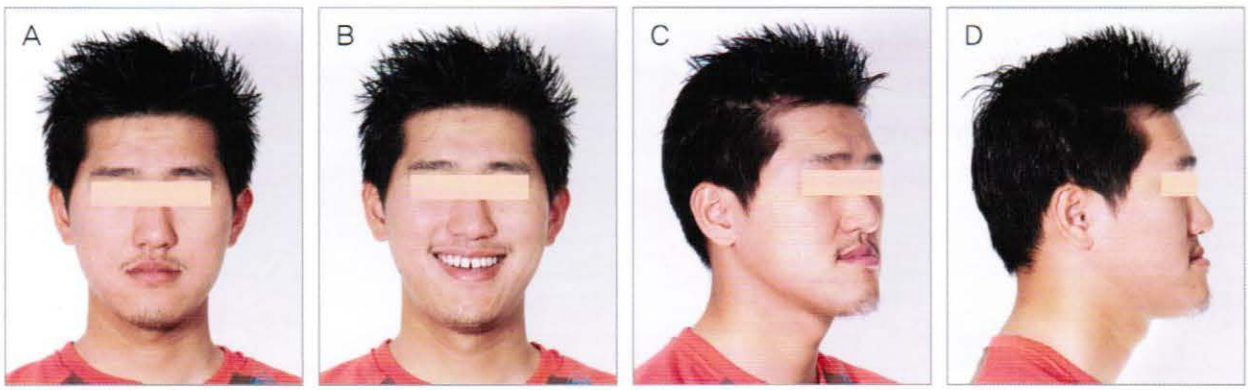


Figure 4-2-1. Pre-treatment facial photograph of Case 5
Chin point is protruded, and the teeth show spacing on smiling.

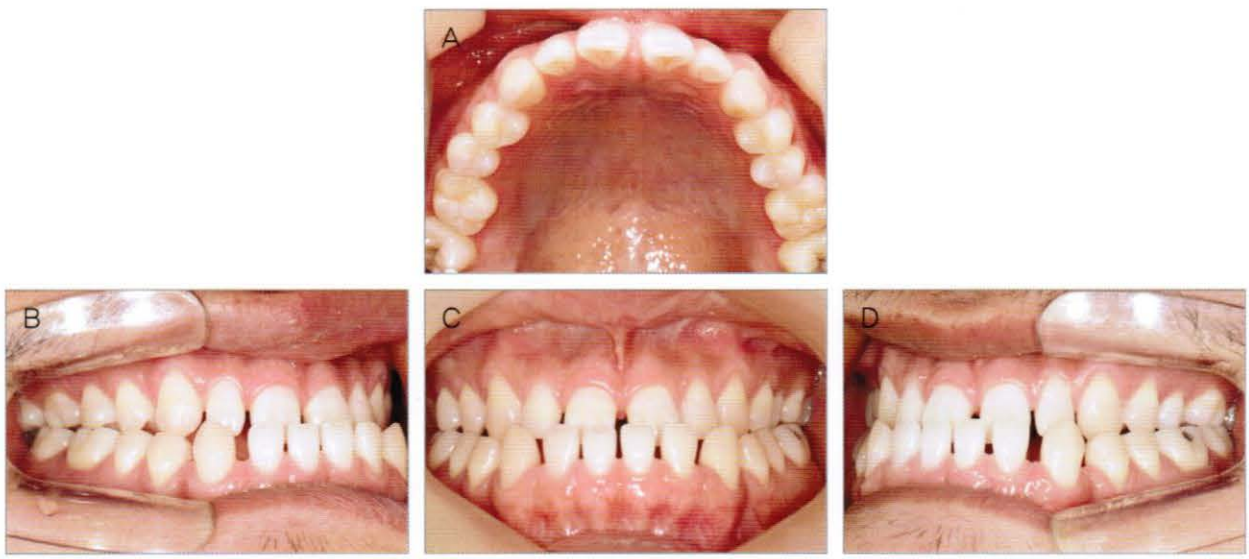
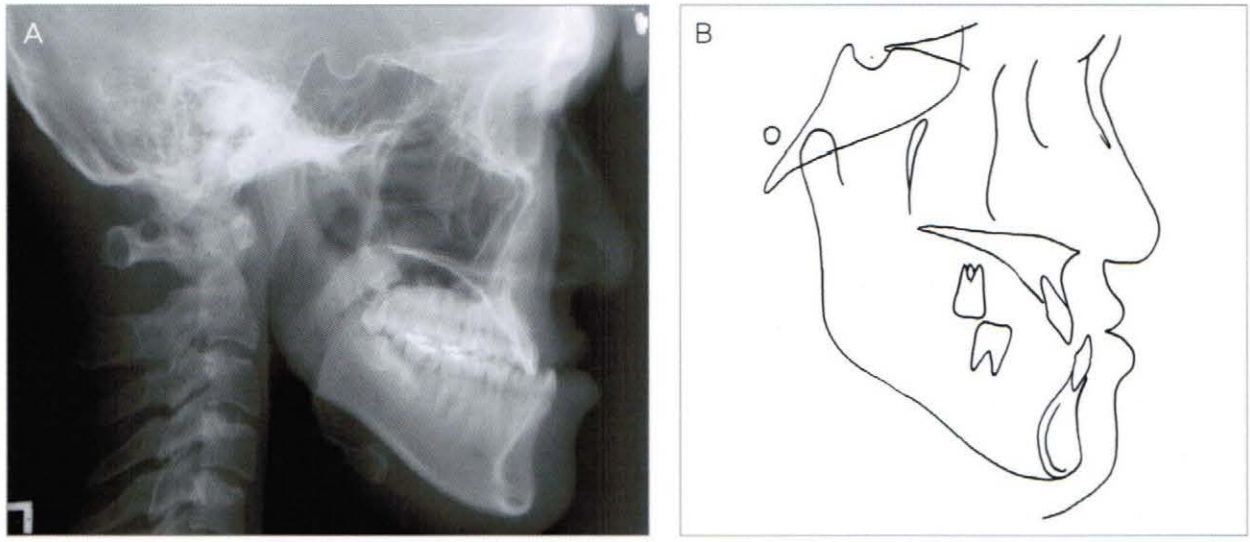


Figure 4-2-2. Pre-treatment intraoral photograph of Case 5
He shows spacing in both arches. There is a reverse curve in the upper arch, and curve of Spee in the lower arch.



C

	Norm	SD	T1
SNA	82.5	3.2	82.5
SNB	80.4	3.1	87.4
ANB	2.1	1.7	−4.8
FMA	22.7	5.3	24.9
U1 to FH	116.3	5.6	117.0
IMPA	96.6	6.6	76.1
IIA	124.4	8.0	142.1
Esth-U	−0.7	2.2	−6.3
Esth-L	0.5	2.3	0.5

Figure 4-2-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. He shows a skeletal Class III malocclusion.
B, C. U1 to FH of 117.0°is larger than normal, and IMPA of 76.1° means that the lower incisors show linguoversion. The interincisal angle is larger than normal with 142.1° During presurgical orthodontics, the lower incisors must be inclined labially. If this is not possible, at least further linguoversion must be prevented.

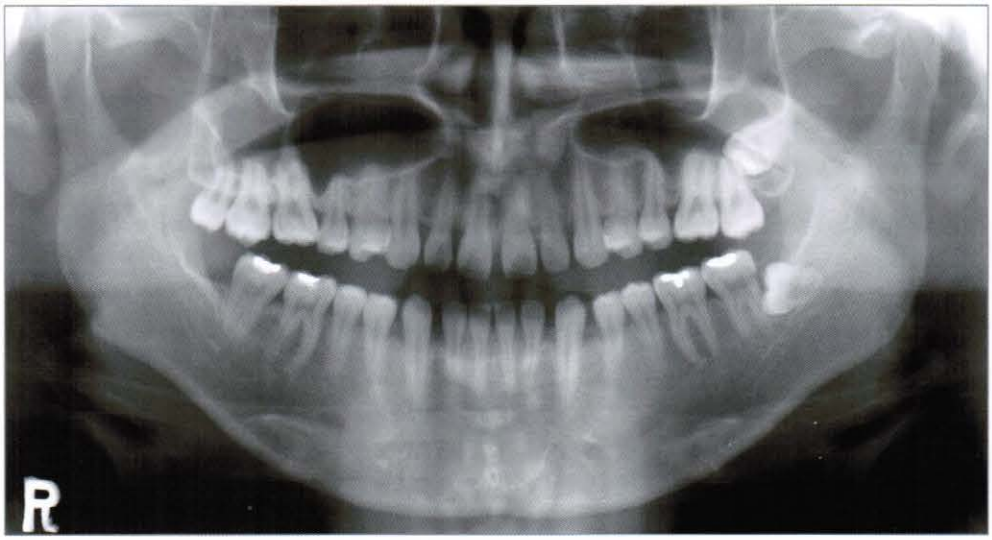


Figure 4-2-4. Pre-treatment panoramic radiograph
The upper and lower left third molar is horizontally impacted. The upper right second molar is overerupted.

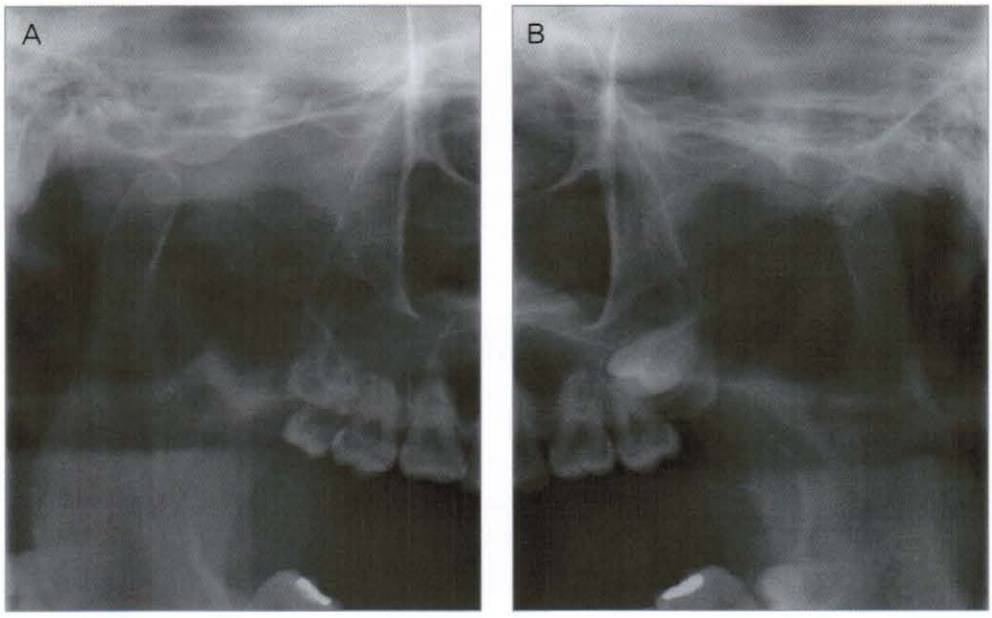


Figure 4-2-5. Pre-treatment TMJ panoramic radiograph
The shape of the mandibular condyles show no abnormalities.

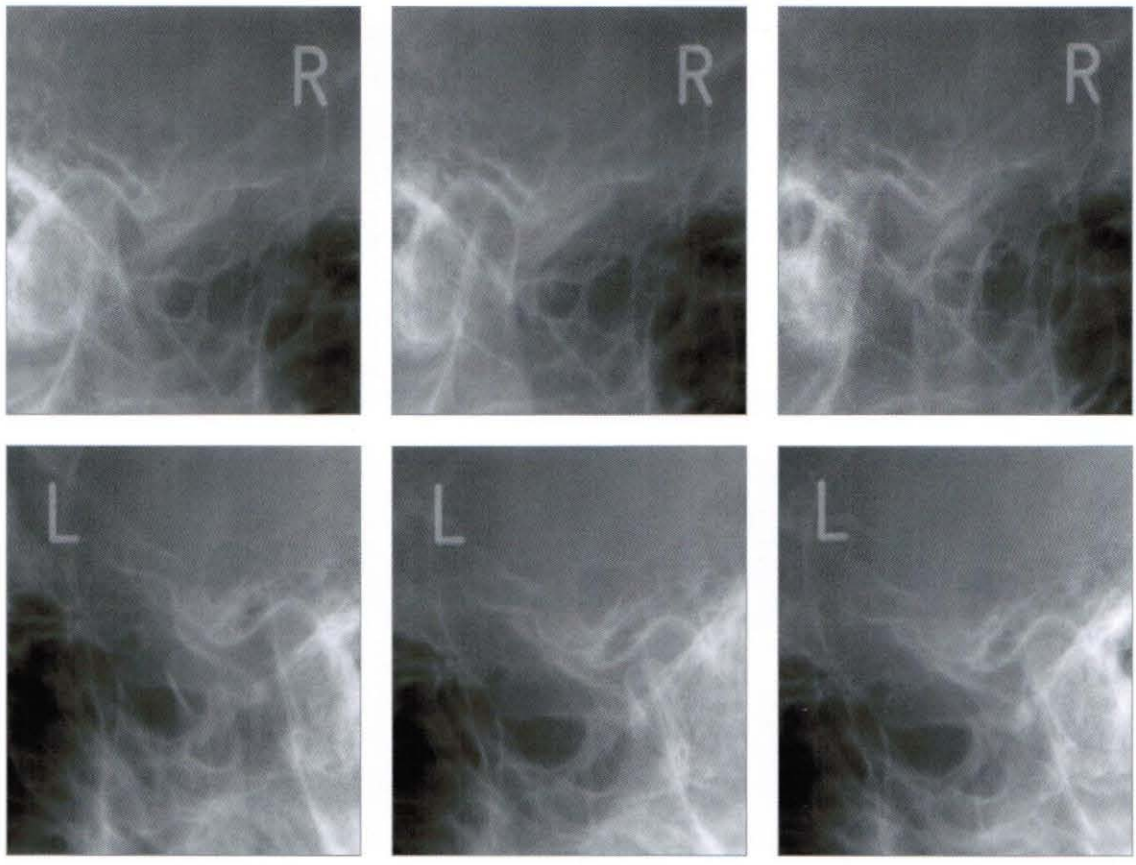


Figure 4-2-6. Pre-treatment transcranial radiograph
To compare the condylar position before and after surgery, a transcranial radiograph was taken pre-treatment.

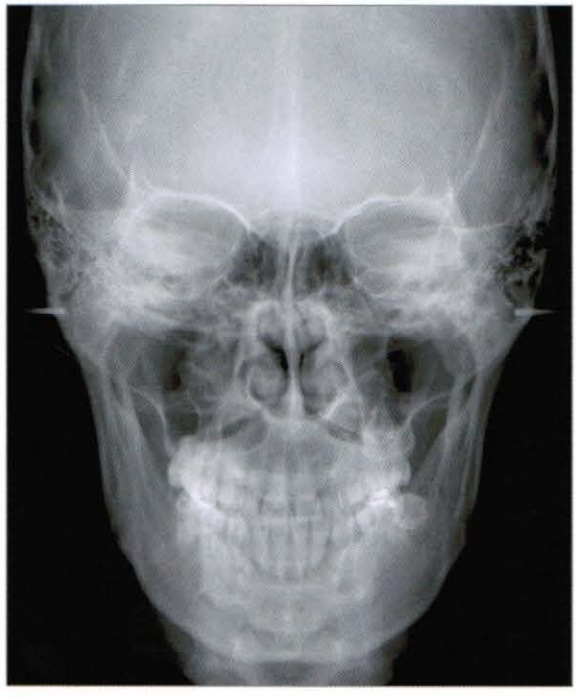
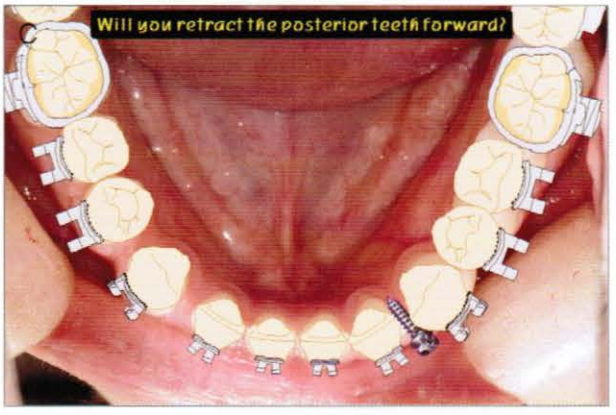


Figure 4-2-7. Pre-treatment postero-anterior radiograph
The left and right sides show symmetry.

In patients with mandibular prognathism, the lower incisors are lingually inclined due to compensation. Therefore labioversion of the lower incisors is required for decompensation before surgery. In this case, linguoversion of the lower incisors in not severe, but removing the spaces will make the linguoversion worse. The key point in this case is minimizing the linguoversion of the lower anterior teeth during presurgical orthodontics. Spacing was closed through protraction of molars by implanting anterior mini-implants.



Clinical tip ››››

When a prognathic mandible patient shows spacing in the lower arch such as the patient in Figure A, will a space be made for a third premolar or protract the posterior teeth forward?

★ Making space for a third premolar (Method B)

Insert open coil spring between the lower canine and first premolar to make space for a third premolar. Refer to Figure B.

[Advantages] – lower incisors can be inclined more labially if required.
– simple procedure

[Disadvantages] – extra fee for prosthodontics is required.
– difficult to obtain good interdigitation between the upper and lower dentition.

★ Using mini-implants for mesial movement of lower molars (Method C)

First remove the extra space between the lower incisors, and insert a mini-implant close to the distal area of the lateral incisor root. This is used as anchorage for moving the canine and posterior teeth forward. Refer to Figure C.

[Advantages] – there is no need for prosthodontics
– easier to obtain good interdigitation

[Disadvantages] – difficult to treat the original linguoversion

※ Note – if lower spacing is removed without any of the above measures, linguoversion of the lower incisors will become worse.

Treatment Progress

■ Leveling — 8 months

- 2004. 10.5 — 014″ NiTi
- 2004. 11.2 — 016″ NiTi
- 2004. 11.30 — L : 016×022″ NiTi
- 2004. 12.28 — U : 016×022″ NiTi
- 2005. 2.23 — 016×022″ ss
- 2005. 3.25 — 018×022″ ss with shoe hooks + TPA with hooks (7|7 intrusion)

■ Implantation

- 2005. 6.3 — 1.6×6.0 2EA $\overline{3\uparrow 2|2\uparrow 3}$

■ Space closing — 12 months

- 2005. 6.24 — L : 019×022″ ss with shoe hooks and guiding wires
- 2006. 4.7 — L : 019×022″ ss with L loops for $\overline{7|7}$

■ Orthognathic surgery — 3 months

- 2006. 6.18 — Two-jaw surgery
- 2006. 9.6 — Removal of mini-implants

■ Detailing — 9 months

- 2006. 7.12 ~ 2007. 4.25 — 018×022″ ss with Bull loops

■ Debonding

- 2007. 4.25

Total 32 months

Refer to photographs for explanations of each step.

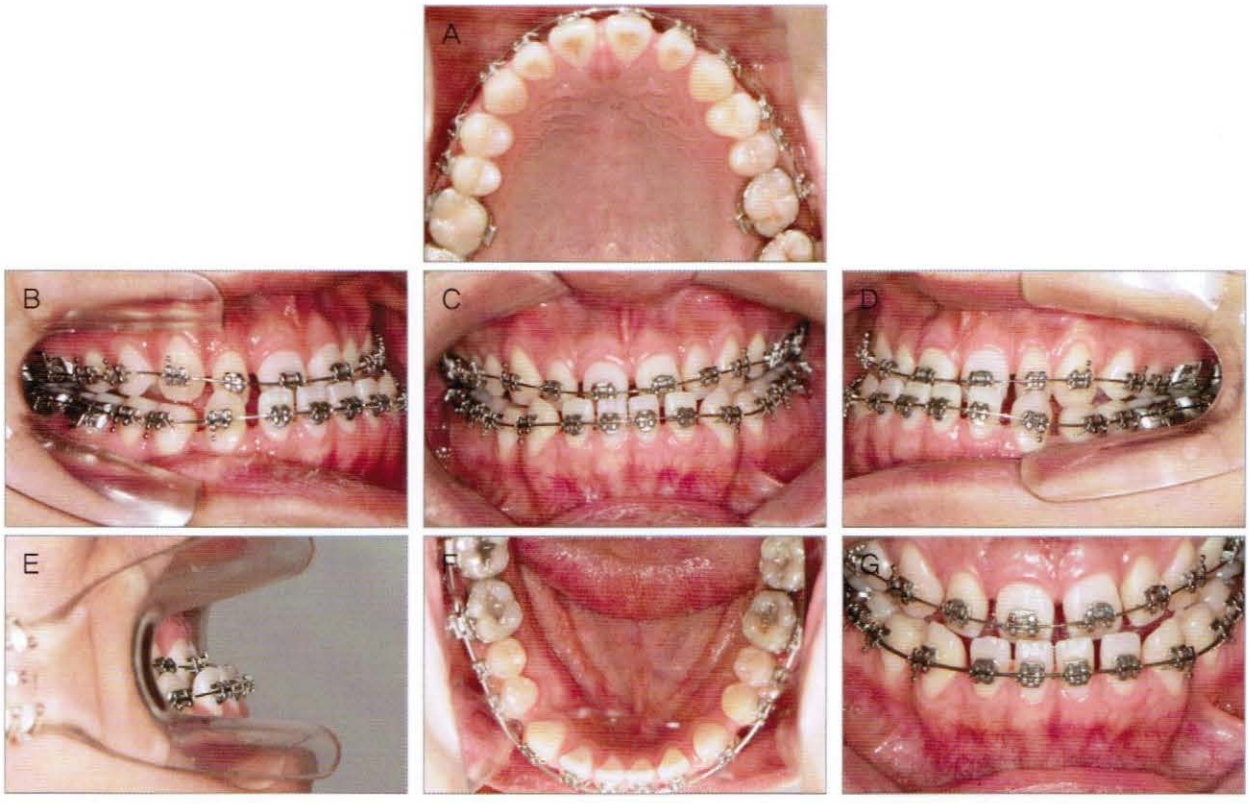


Figure 4-2-8. Leveling stage
After use of 014″ NiTi and 016″ NiTi, 016×022″ NiTi has been ligated (2004. 11.30).

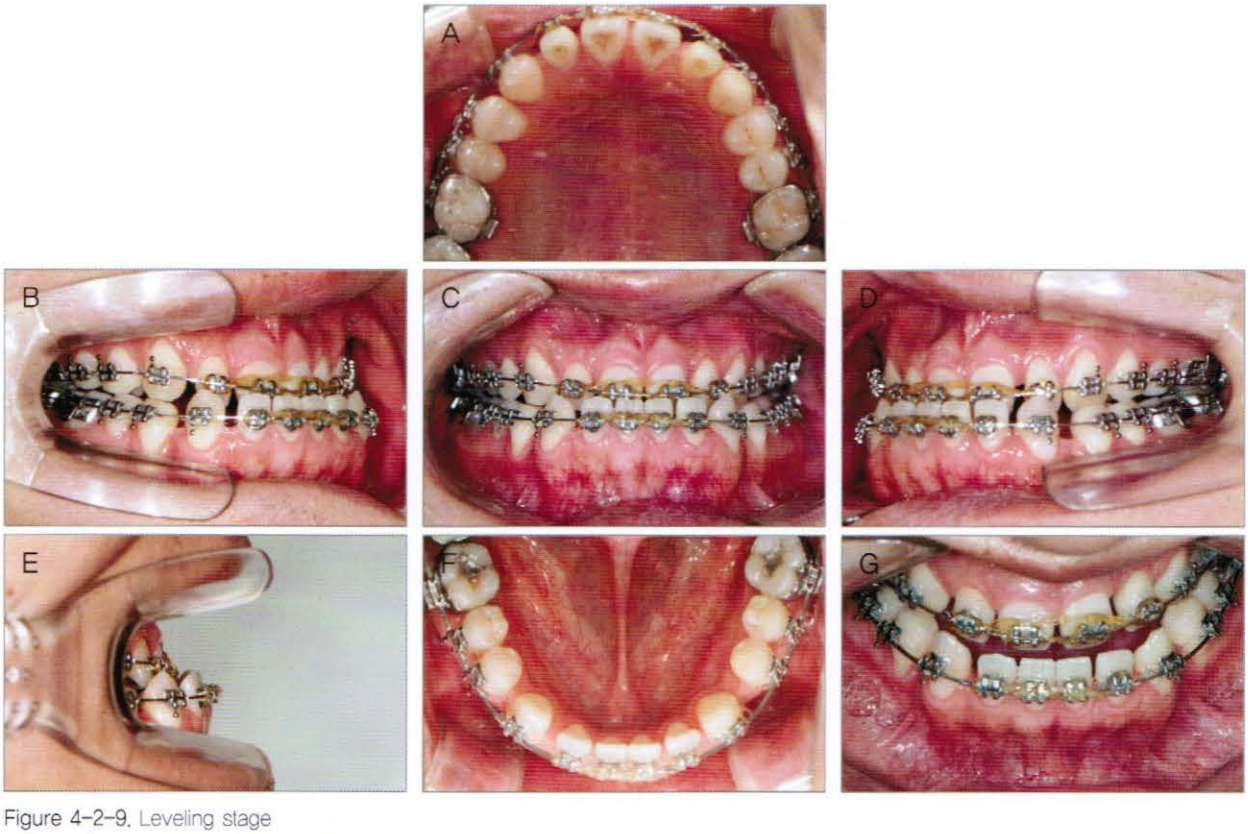


Figure 4-2-9. Leveling stage
016×022″ ss is inserted (2005. 2.23).

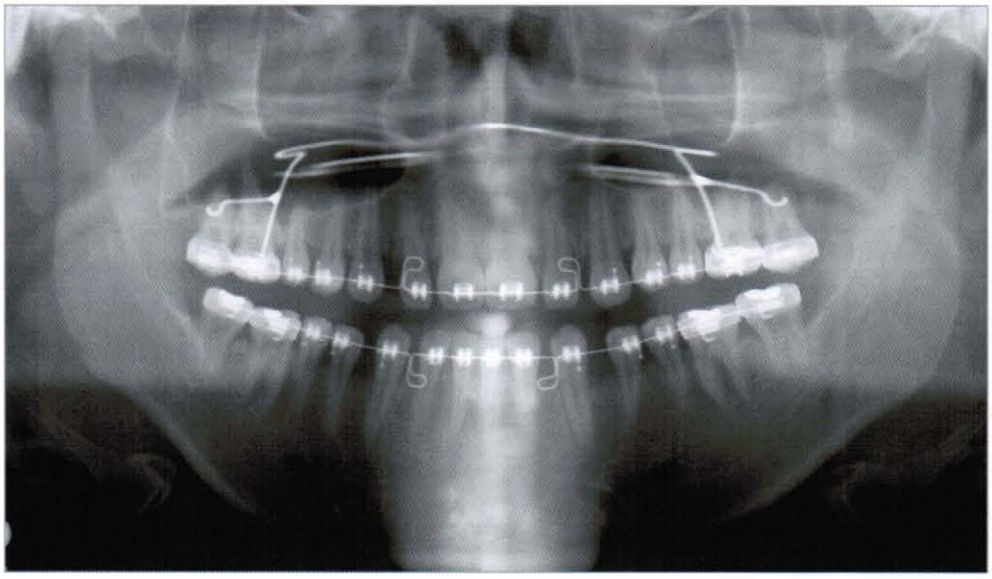


Figure 4-2-10. Panoramic radiograph after leveling
The condition of the roots was checked before insertion of mini-implants. The space between the 4 lower incisors has been closed. 018×025″ ss with shoe hooks are inserted in both arches. For treatment of upper second molar extrusion, TPA with hooks is being used for intrusion (2005. 4.29)

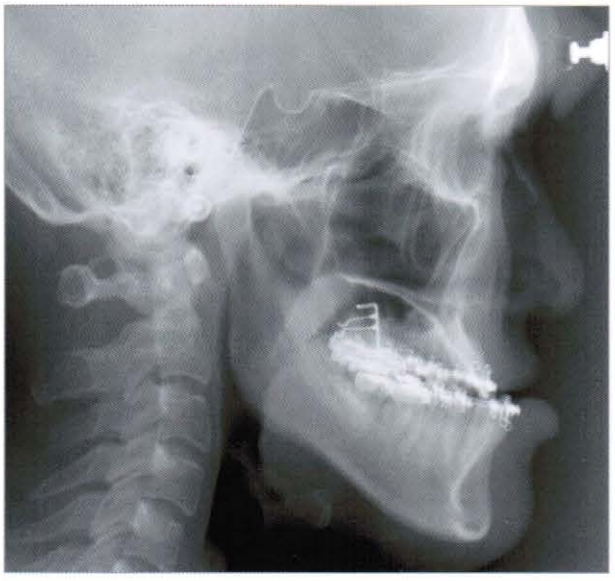


Figure 4-2-11. Cephalometric radiograph after leveling
The position and axis of the lower incisors are checked. It is decided to maintain this position as much as possible (2005. 4.29)

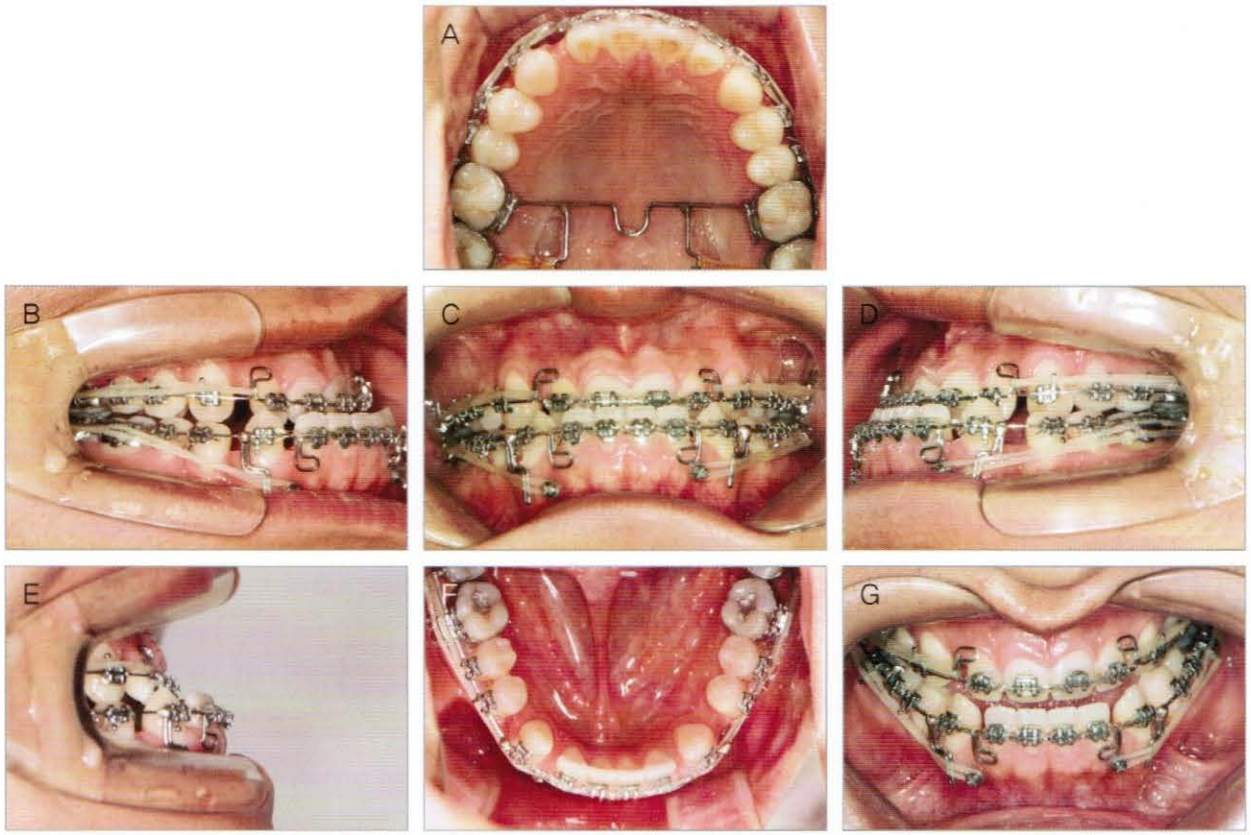


Figure 4-2-12. After mini-implant insertion, the lower molars are being protracted forward (2005. 6.24)
1.6×6.0mm mini-implants were inserted between the lower lateral incisor and canine (2005. 6.3). One week later, guiding wire was soldered onto 019×025" ss wire with shoe hooks and ligated. 5/16" 6 oz elastics were used between the mini-implant head and the lower second molar tube for forward protraction of molars.

Clinical tip ››››

Treatment of extruded upper second molar in mandibular prognathism patients

Buccally, a step or L-loop is placed in the wire to place an intrusive force on the second molar. However if intrusive force is applied only from the buccal side, the palatal cusp cannot be intruded well. Force must be applied from both the buccal and palatal sides. For this, TPA with hooks (Figure 4-2-12A) is used. Power chain is applied from the hook of the TPA to a lingual button (or cleat) bonded onto the lingual side of the second molar.

There are cases where counteraction will cause extrusion of the first molar. In these cases, a mid-palatal mini-implant can be inserted for anchorage reinforcement.

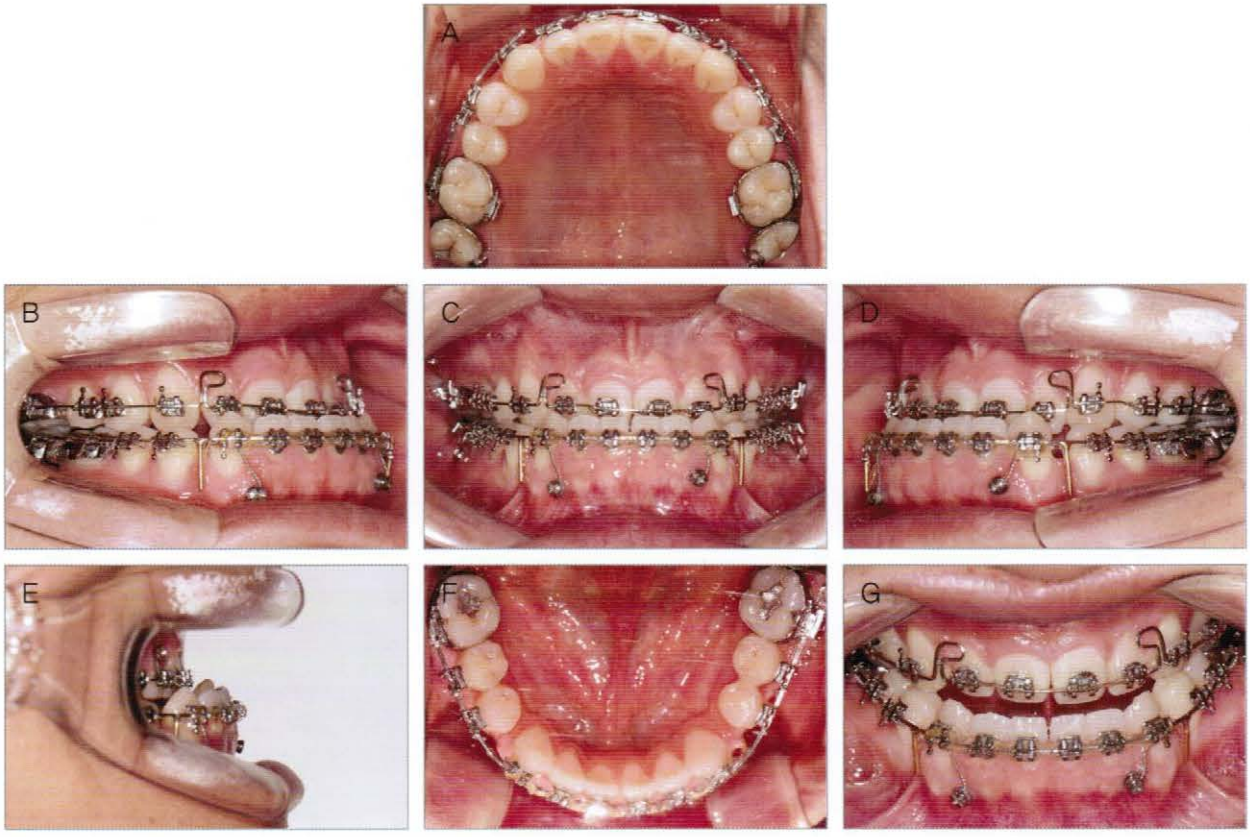


Figure 4-2-13. Presurgical intraoral photograph (2006. 6.2)
The mini-implant head and lower incisor brackets have been tightly ligated. For correction of lower second molars, L-loops were included between the first and second molars in 019×025″ ss wire with shoe hooks. All the spaces between the lower incisors were not closed, but it was decided to continue space closure after surgery.

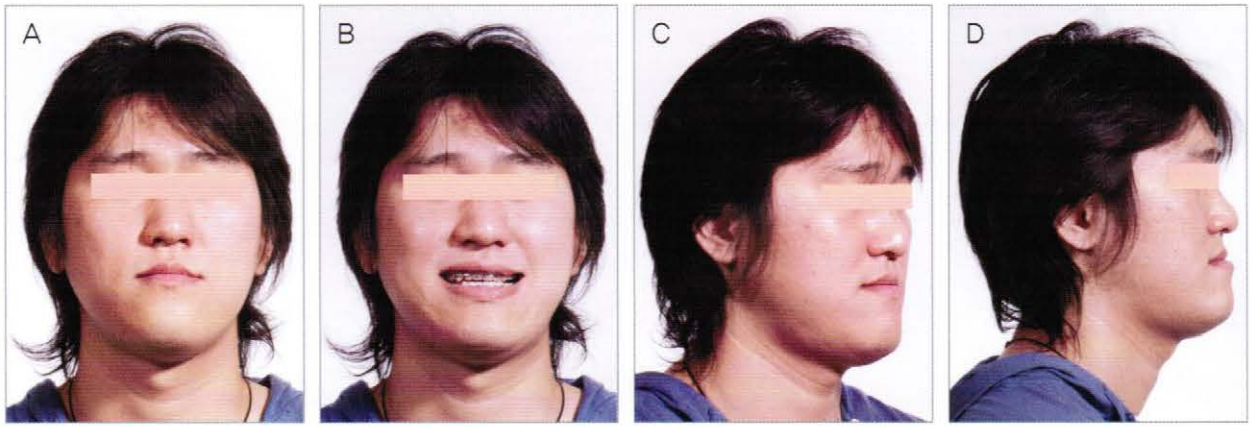
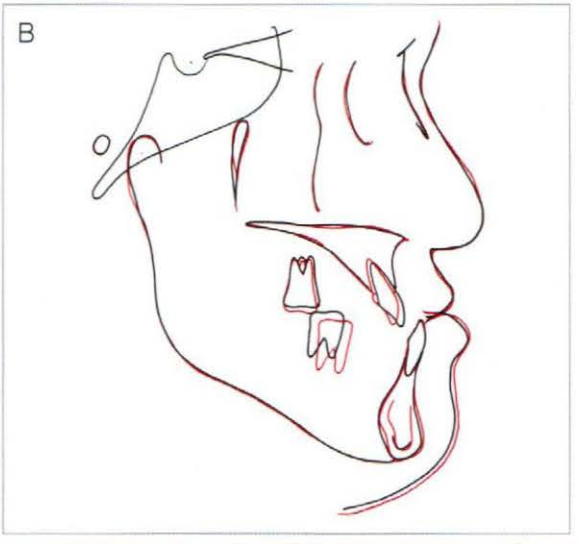
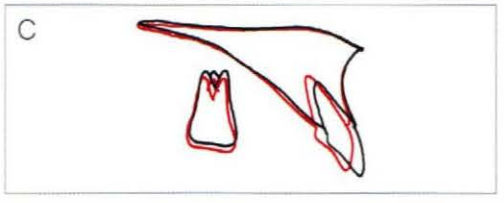
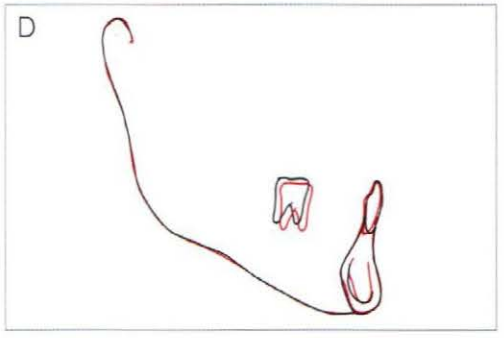


Figure 4-2-14. Presurgical facial photograph







E

	Norm	SD	T1	T2
SNA	82.5	3.2	82.5	81.1
SNB	80.4	3.1	87.4	86.5
ANB	2.1	1.7	−4.8	−5.4
FMA	22.7	5.3	24.9	21.5
U1 to FH	116.3	5.6	117.0	113.5
IMPA	96.6	6.6	76.1	78.3
IIA	124.4	8.0	142.1	146.9
Esth-U	−0.7	2.2	−6.3	−7.3
Esth-L	0.5	2.3	0.5	−0.4

Figure 4-2-15. Presurgical cephalometric radiograph and measurements
Slight linguoversion of the upper incisors has occurred. There has been no linguoversion of the lower incisors.
T1 : Pre-treatment, T2 : Before surgery

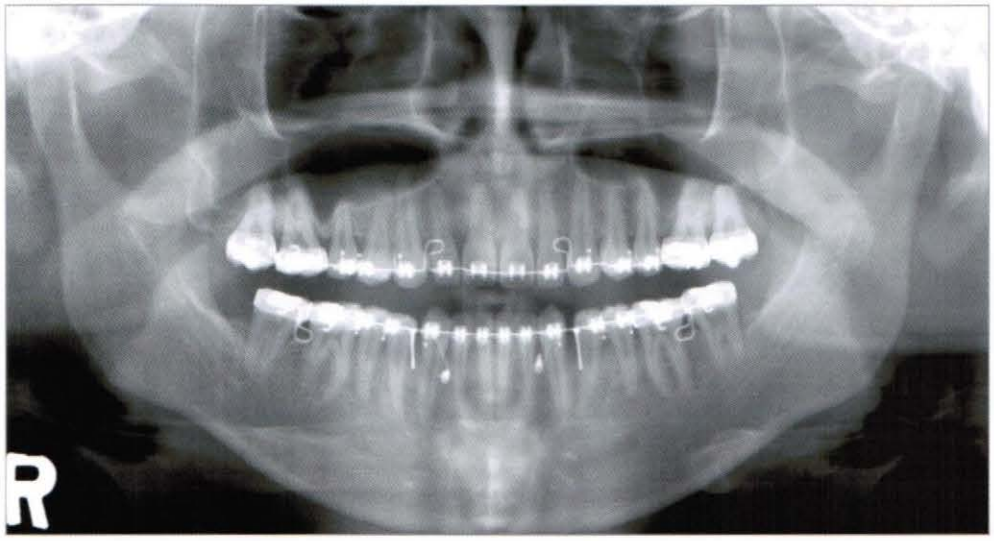


Figure 4-2-16. Presurgical panoramic radiograph

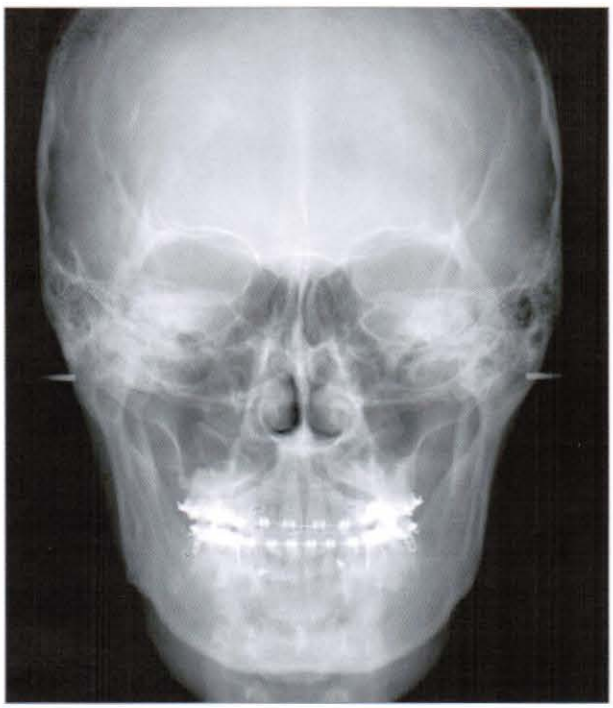


Figure 4-2-17. Presurgical postero-anterior radiograph

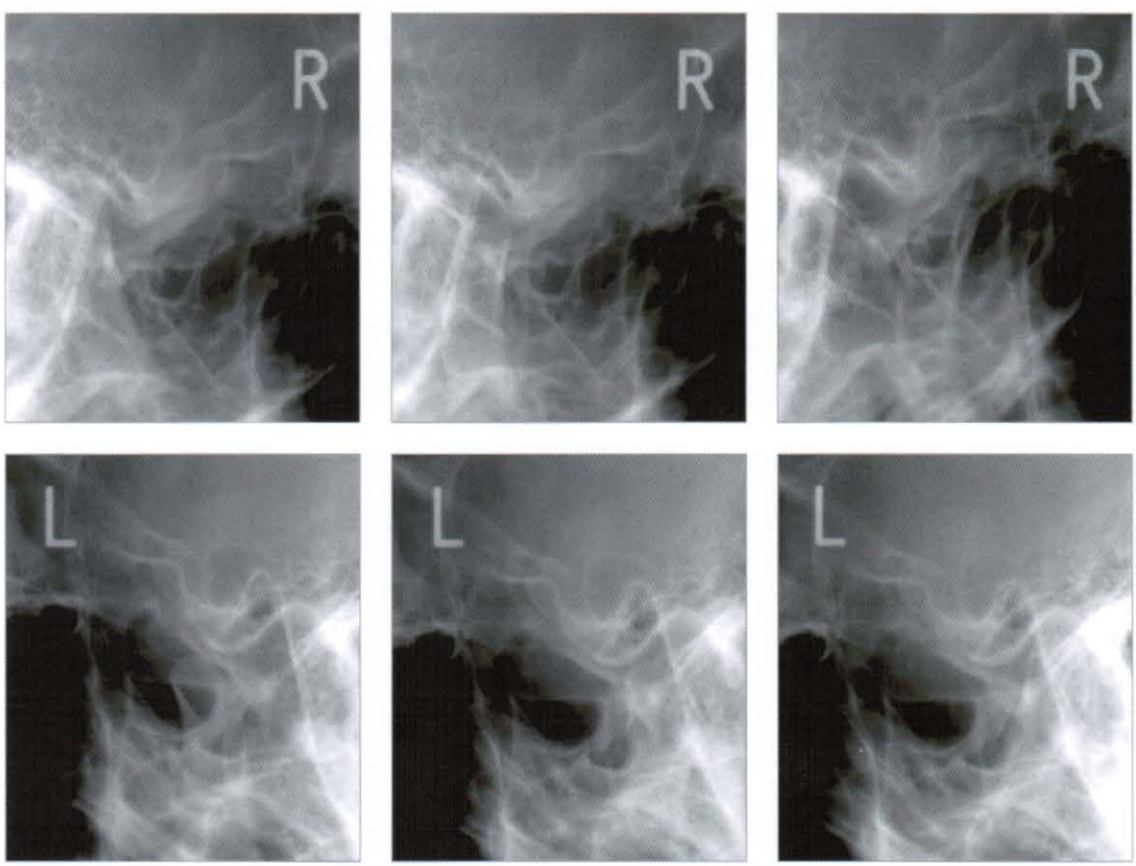


Figure 4-2-18. Presurgical transcranial radiograph

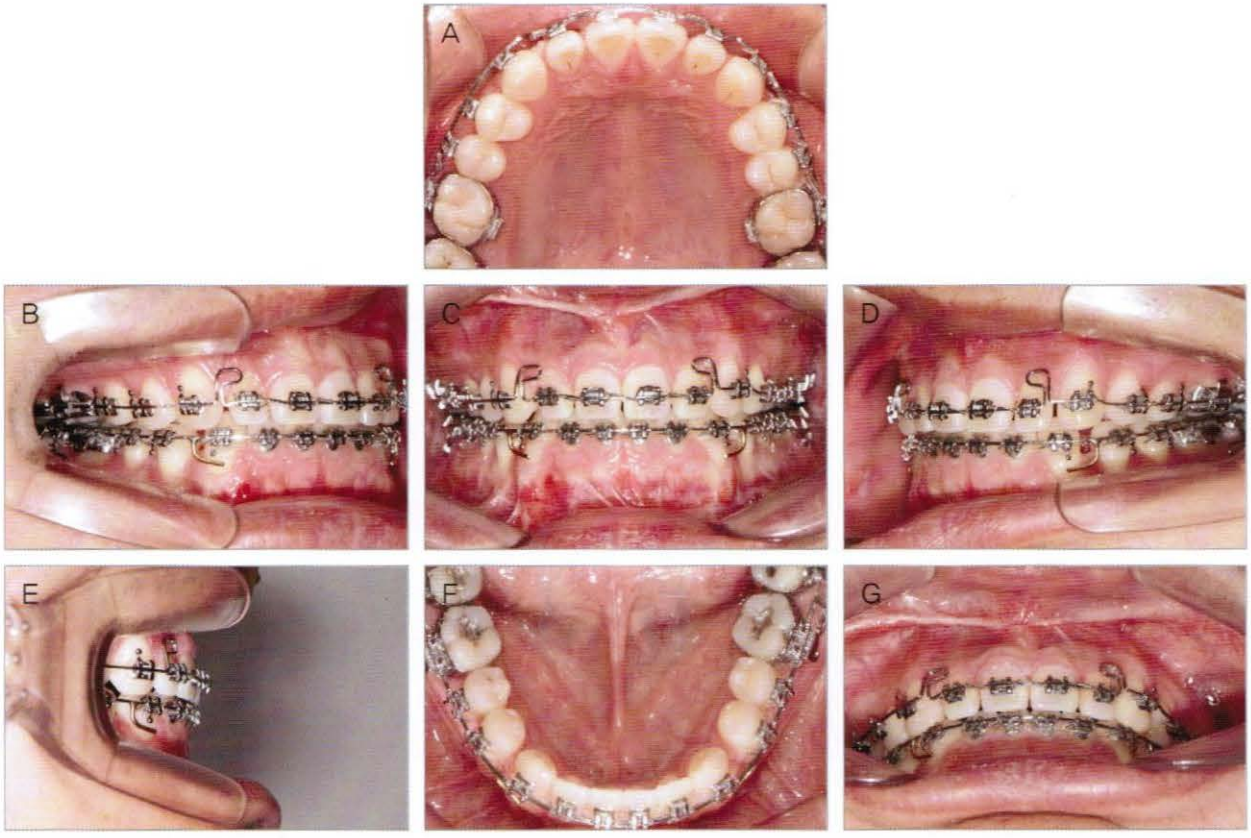


Figure 4-2-19. Postsurgical intraoral photograph (2006. 9.6)
Bull loop (018×022″ ss) is being used for space closure of the remaining space.

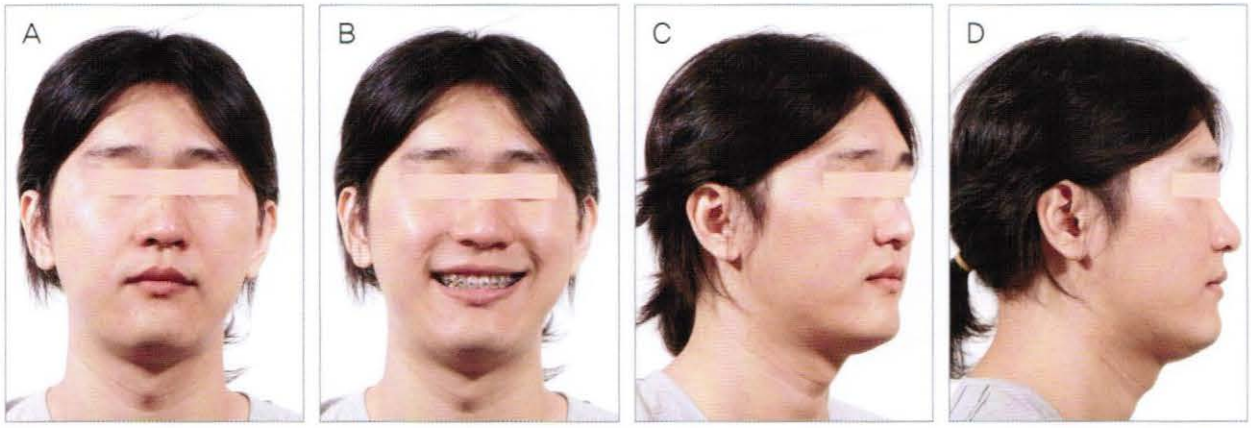


Figure 4-2-20. Postsurgical facial photograph

〈Surgical record〉

Upper : LeFort I
- midline shift to right side 1mm
- posterior impaction 2mm
- anterior elongation 3mm

Lower : BSSRO setback
- right and left sides 8mm
- genioplasty 4mm advancement

Figure 4-2-21. Postsurgical cephalometric radiograph

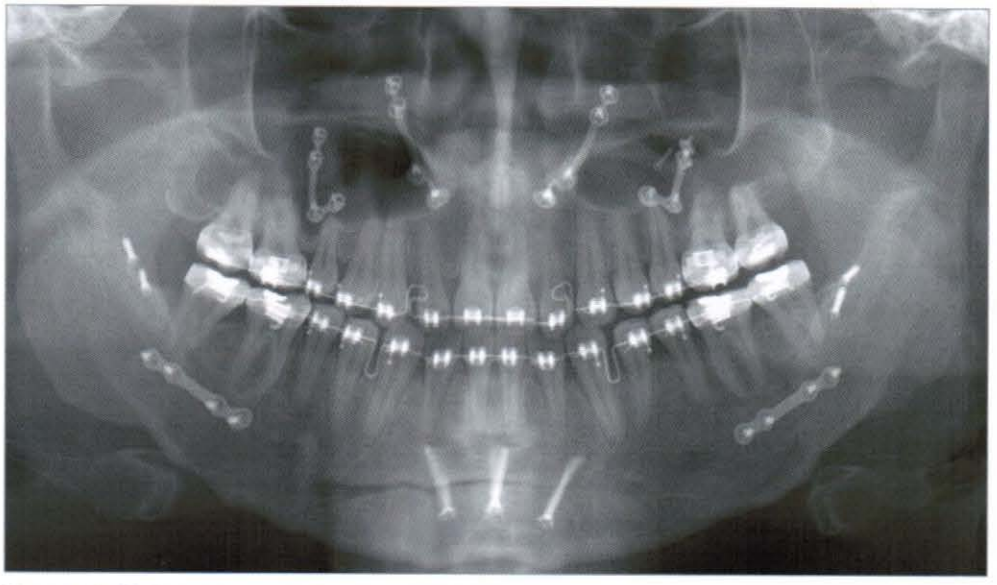


Figure 4-2-22. Postsurgical panoramic radiograph

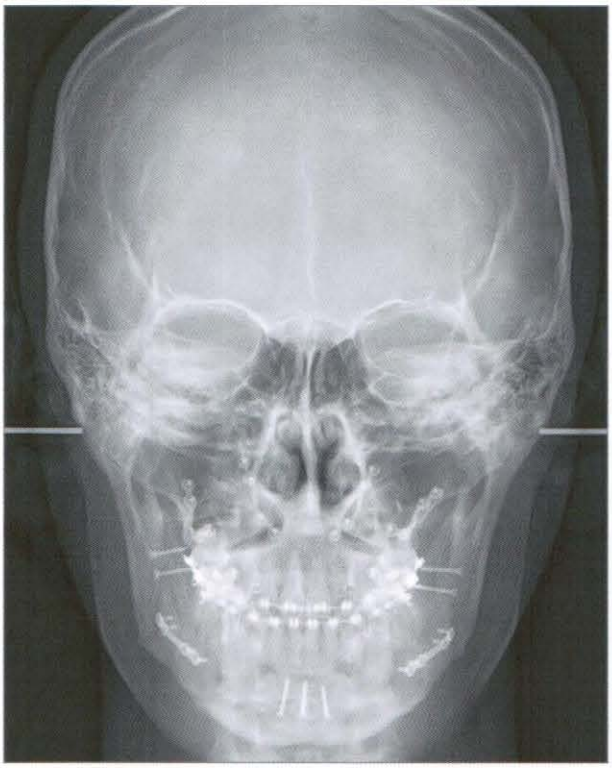


Figure 4-2-23. Postsurgical postero-anterior radiograph

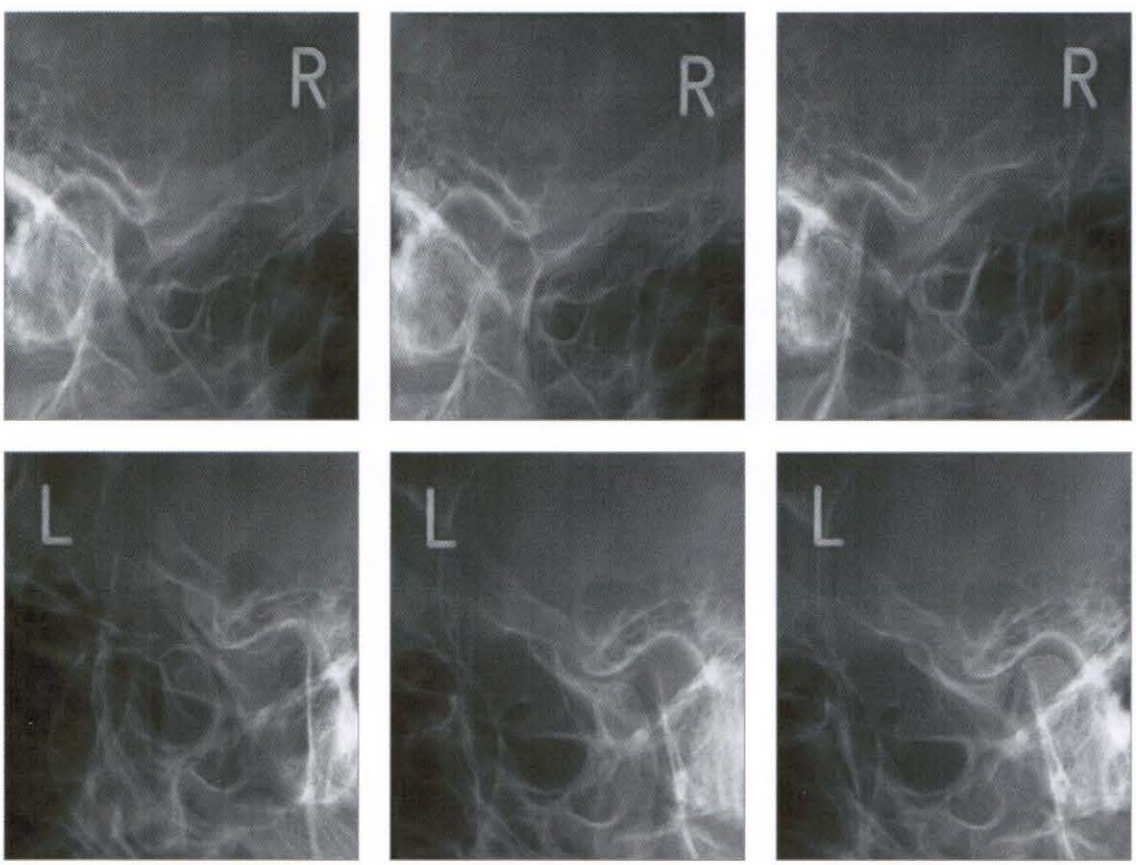


Figure 4-2-24. Postsurgical transcranial radiograph

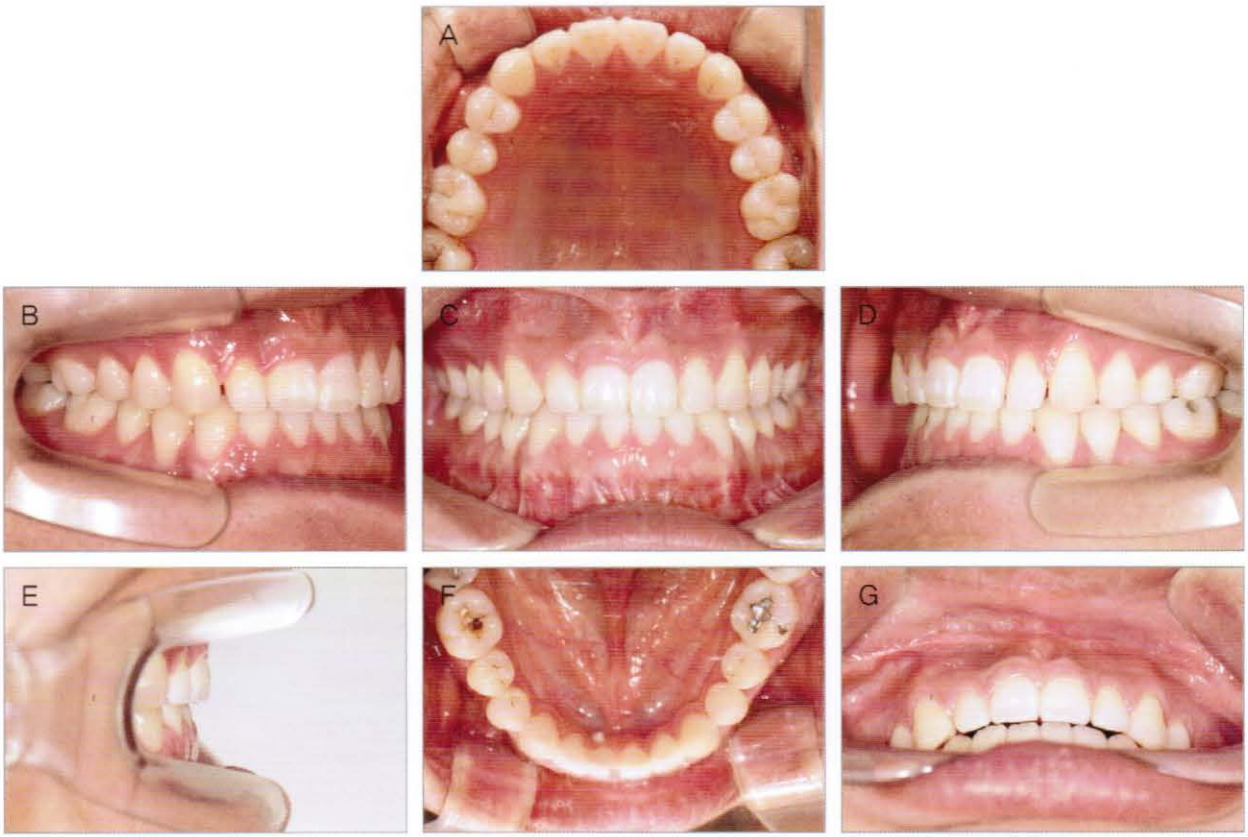


Figure 4-2-25. Intraoral photograph at debonding (2007. 4.25)

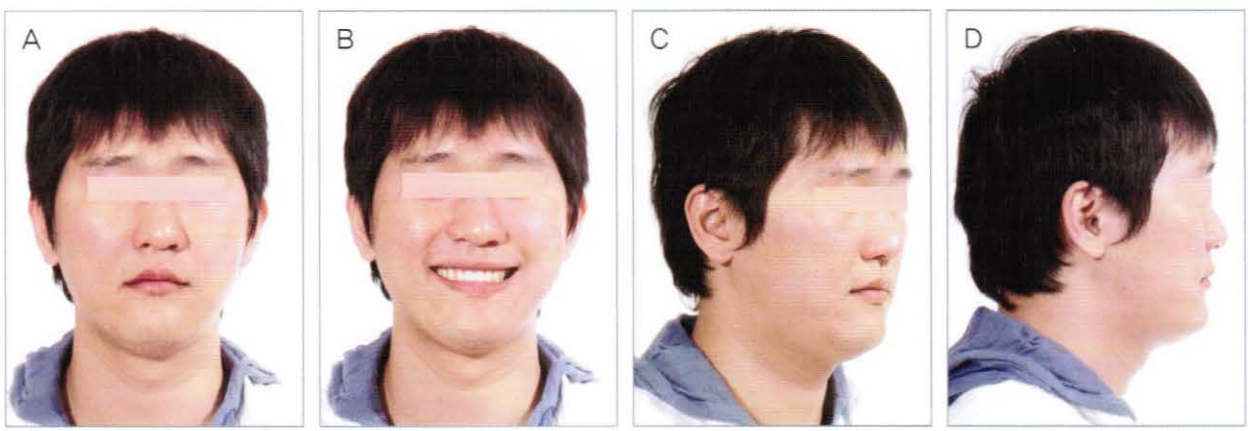
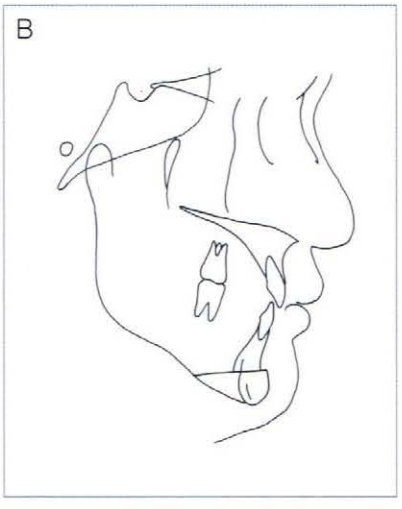
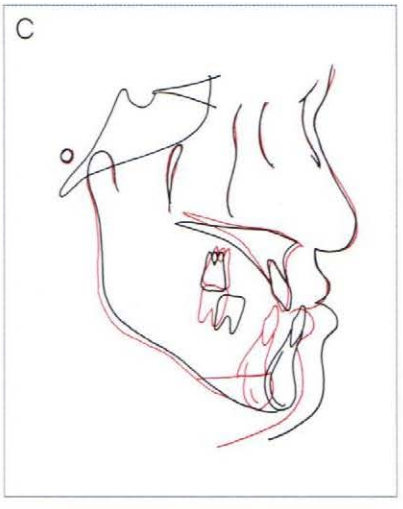
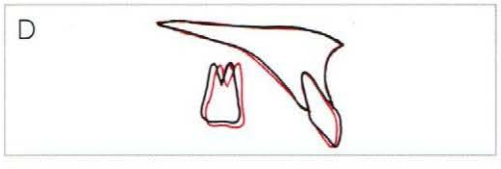
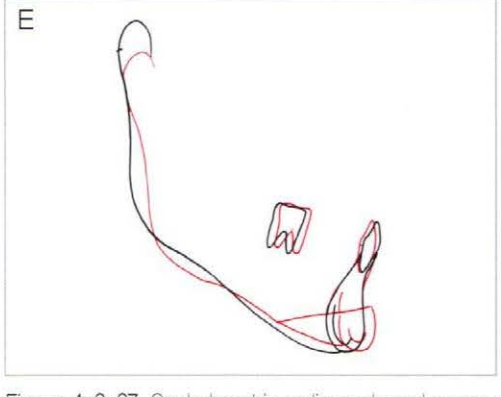


Figure 4-2-26. Facial photograph at debonding (2007. 4.25)









F

	Norm	SD	T1	T3
SNA	82.5	3.2	82.5	84.1
SNB	80.4	3.1	87.4	81.8
ANB	2.1	1.7	−4.8	2.4
FMA	22.7	5.3	24.9	24.5
U1 to FH	116.3	5.6	117.0	106.7
IMPA	96.6	6.6	76.1	77.1
IIA	124.4	8.0	142.1	151.7
Esth-U	−0.7	2.2	−6.3	−4.2
Esth-L	0.5	2.3	0.5	−5.2

Figure 4-2-27. Cephalometric radiograph and measurement at debonding
A. Post-treatment cephalometric radiograph
B. Post-treatment cephalometric tracing
C, D, E. Pre-treatment and post-treatment superimposition
F. Measurement
Comparing pre-treatment and post-treatment, linguoversion of the upper incisors has occurred. The lower incisor axis has been well maintained.
T1 : Pre-treatment, T3 : Post-treatment

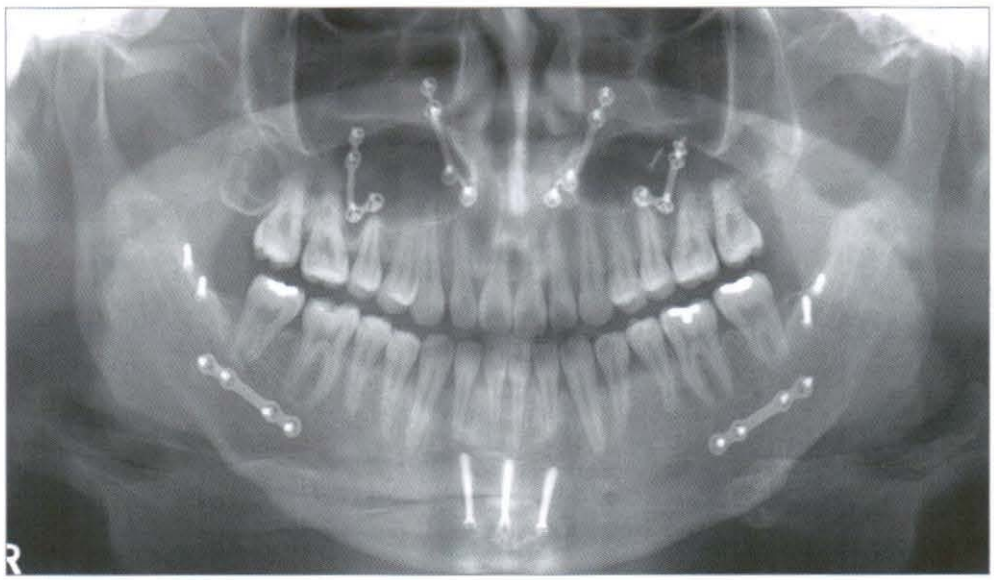


Figure 4-2-28. Panoramic radiograph at debonding

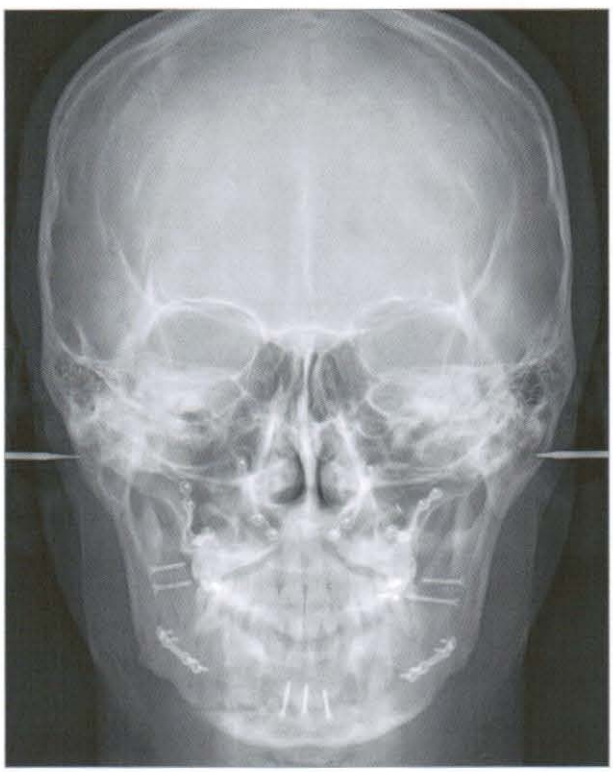
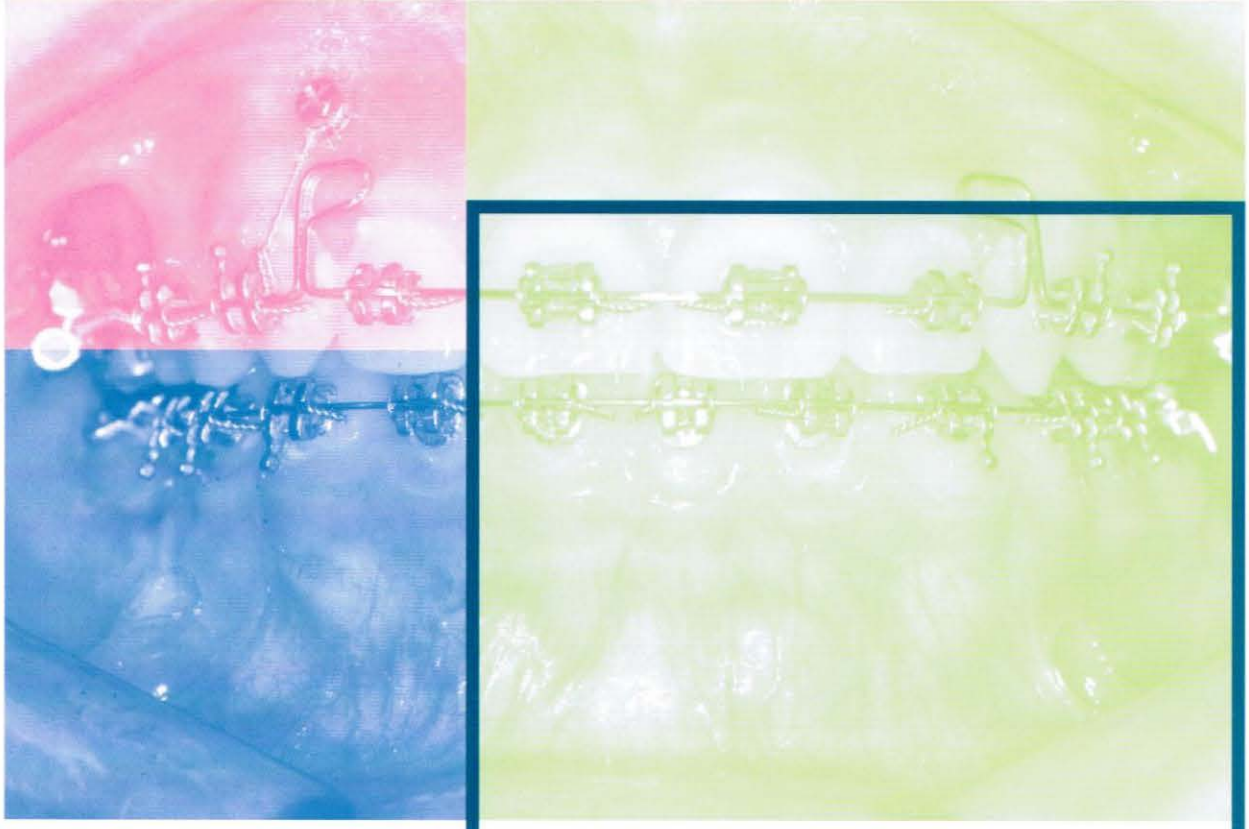


Figure 4-2-29. Postero-anterior radiograph at debonding



Chapter 5

Molar intrusion

Chapter 5

Molar intrusion

Mini-implants are considered an epochal discovery for orthodontic treatment due to two reasons. Firstly, reinforcement of anchorage is easily achieved, and secondly, tooth intrusion has been made possible. By providing techniques to allow molar intrusion, many cases have been treated without the need for orthognathic surgery, and simplified difficult cases.

Ⅰ. Various methods of molar intrusion

Methods to treat open bite are presented. First the position of mini-implant insertion should be examined, and one of the methods outlined below are chosen. Depending of the case, around 2~3mm of intrusion is possible.

Indications

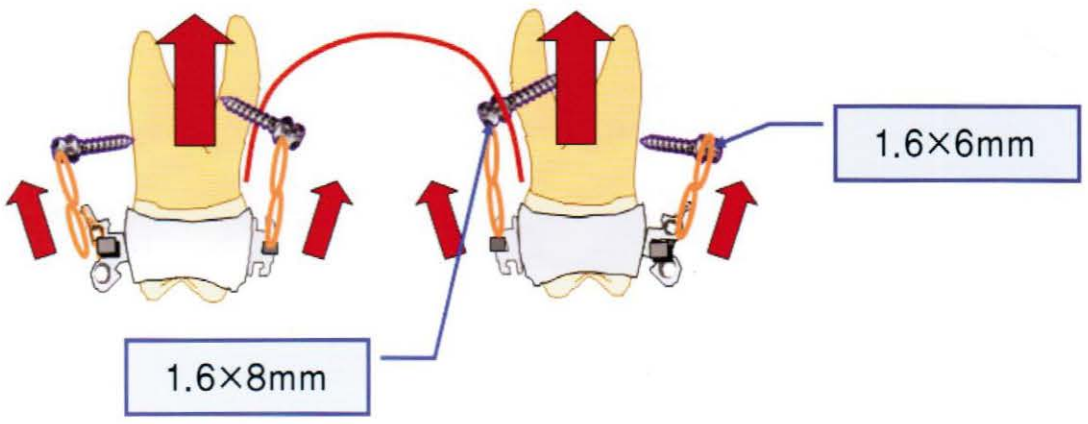
Open bite cases where molar intrusion is possible include the following.

- Class Ⅱ open bite with normal mandibular length, which can be corrected by autorotation of the mandible.
- Lip incompetency due to excessive lower anterior facial height.
- Mild skeletal openbite, not severe.
- Space available for the posterior teeth to be intruded.
- Extraction cases are good. There should be no posterior discrepancy.

Methods of intruding upper first molars (Figure 5-1-1 to 5)

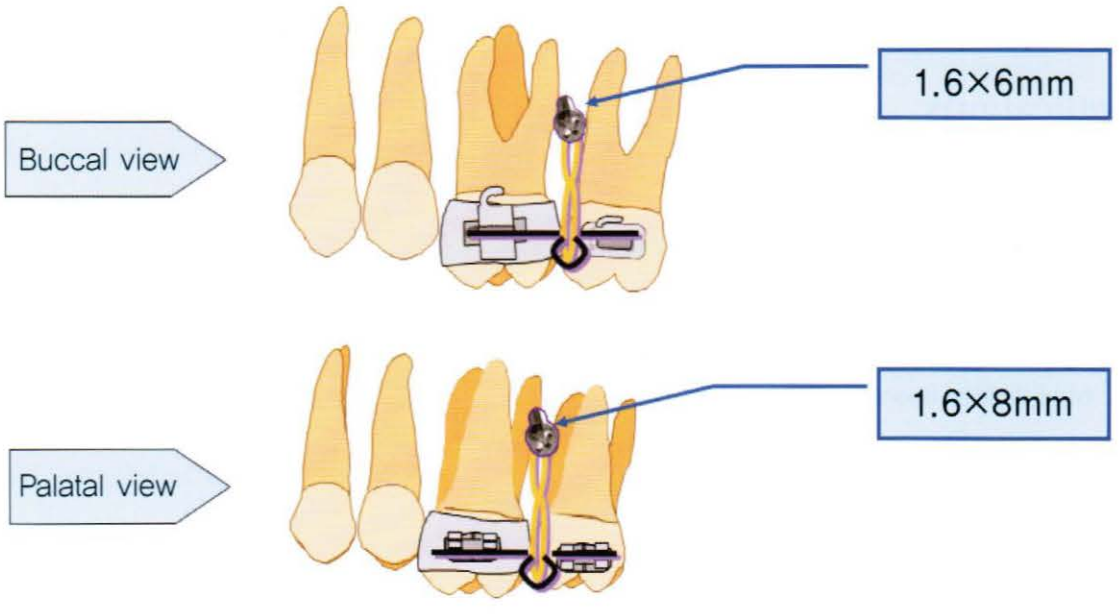
Method 1

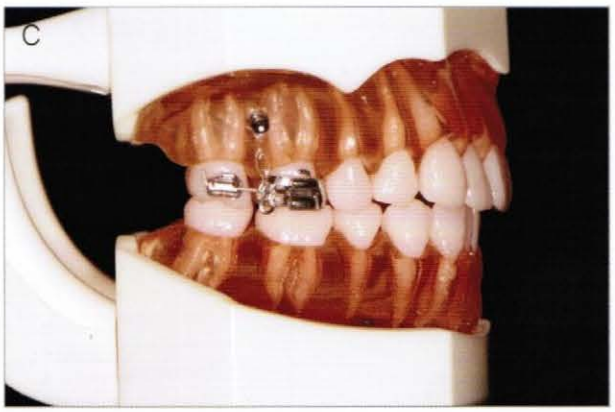
A



This is the simplest method to intrude molars. Two forces from the buccal and palatal sides on one tooth will exert an intruding force without tipping.

B





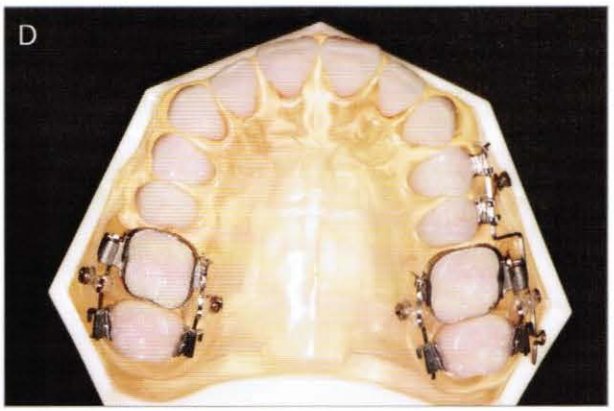


Figure 5-1-1. Illustration of Method 1
A. Cross-sectional view
B. View from buccal and palatal sides
C. Buccal structure seen on dentiform model
D. Palatal structure seen on dentiform model

Clinical tip ››››

- **Mini-implants**
  - Buccal : 1.6x6.0 between 6 and 7
  - Palatal : 1.6x8.0 between 6 and 7
- **Brackets**
  - Buccal : 022" MBT or Roth set-up SWA
    - Wide brackets on 6 & 7
    - Medium brackets on 4 & 5, if necessary
  - Palatal : 018" Standard
- **Wires**
  - Buccal : 018x025" ss or heavier
  - Palatal : 016x022" ss or heavier

Advantages

1. It is easier to control tilting of the tooth buccally or palatally.
2. If a mini-implant is inserted between the first and second molars, it quickly intrudes the last molar which acts as a wedge that keeps the bite open. The open bite is effectively closed.

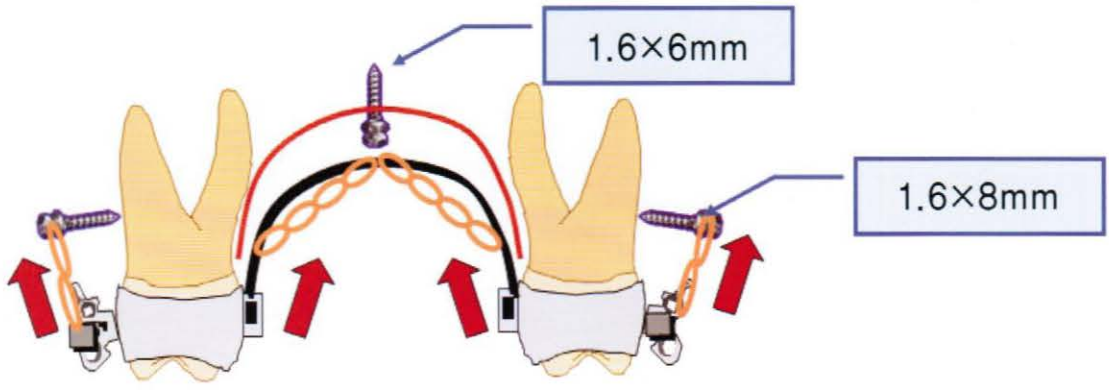
Disadvantages

1. It is difficult to find a good indication. There are not many cases where the interradicular space between the first and second molars is wide enough. In such cases, the mini-implant can be inserted between the second premolar and first molar, but the effectiveness decreases. The mini-implant should be inserted as far distally as possible for effective treatment of open bite.
2. Mini-implant failure occurs fairly often with molar intrusion. The reason for this is that the mini-implant becomes closer to the alveolar crest with intrusion, and makes the space between roots narrower. This causes the mini-implant to be exposed to trauma from occlusal forces or tooth movement.

▶ **Refer to Case 6 for actual application of these mechanics.**

Method 2

A



This is a method which uses a midpalatal and two buccal mini-implants with a TPA to intrude molars.

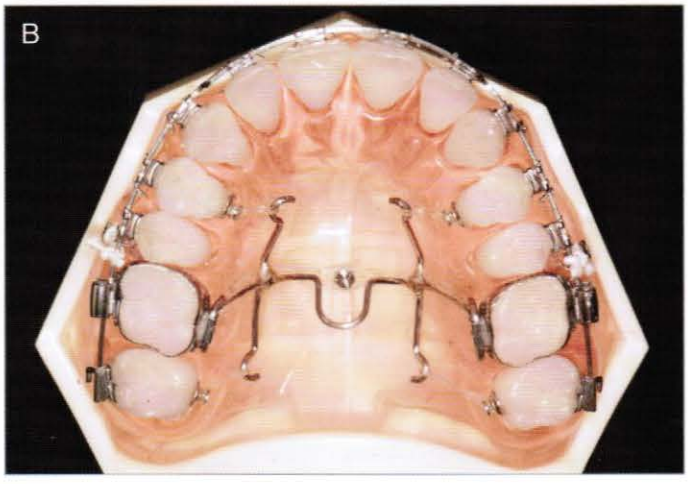


Figure 5-1-2. Method 2

A. Illustration of cross-sectional view. Instead of two mini-implants between roots, one mini-implant has been inserted in the mid-palatal suture area. Intrusion force is given through the TPA.

B. Mid-palatal mini-implant and TPA shown on dentiform model. For intrusion of premolar and second molar palatal cusps, extra hooks have been soldered onto the TPA.

Clinical tip ››››

- **Mini-implants**
  - Buccal : 1.6x6.0 between 6 and 7 or between 5 and 6
  - Mid-palatal : 1.6x6.0
    - On a line connecting the mesial openings of 6' s palatal sheaths
- **Brackets**
  - Buccal : 022" MBT
  - Palatal : Palatal sheath
- **Wires**
  - Buccal : 019x025" ss or heavier
- **Palatal TPA with hooks : 0.9mm ss**
  - Space more than 3mm between the TPA and the palatal mucosa. Otherwise, TPA will impinge on the mucosa as the upper molars are intruded.
  - If palatal cusps of the second molars and the bicuspids need to be intruded, solder hooks to the TPA for intrusion.

Advantages

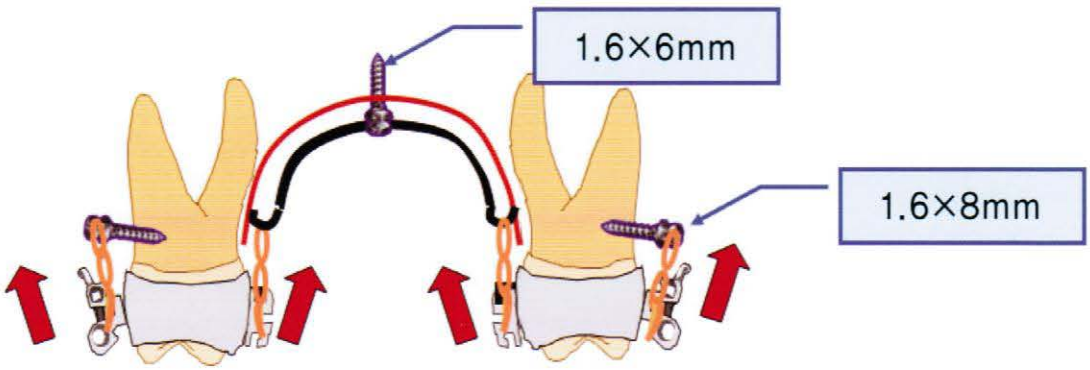
1. Mid-palatal mini-implants are very stable. Failure rate is low. Even if buccal mini-implants fail, continued intrusion is possible with the mid-palatal implant (Refer to Method 5).

Disadvantages

1. Buccal mini-implant can fail, as in Method 1.
2. TPA and wires may cause discomfort for the patient.

Method 3

A



This is a method using two midpalatal mini-implants connected to each other through a bar.

B

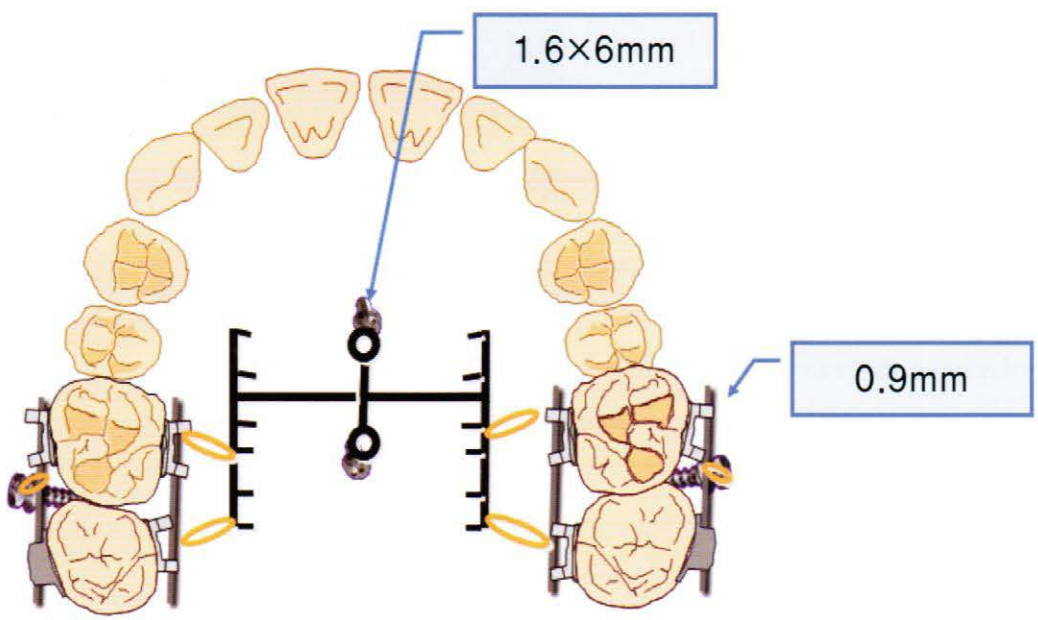


Figure 5-1-3. Method 3
A. Cross-sectional view B. Illustration seen from the occlusal surface

Clinical tip ››››

■ Mini-implants

- Buccal : 1.6x6.0 between 6 and 7 2 EA
- Mid-palatal : 1.6x6.0 2 EA
  - Two mini-implants at the mid-palatal suture area. One 5mm anterior to a line connecting the mesial openings of 6's palatal sheaths and the other 5mm posterior to the line.
  - Two mini-implants are connected with a bar, bonded or attached.

■ Brackets

- Buccal : 022" MBT
- Palatal : 018" Standard
  - Wide brackets on 6 & 7
  - Medium brackets on 4 & 5, if necessary

■ Wires

- Buccal : 019x025" ss or heavier
- Palatal : 018x022"
- Palatal bars : 0.9mm or heavier
  - Bonded or attached to the mid-palatal mini-implants.

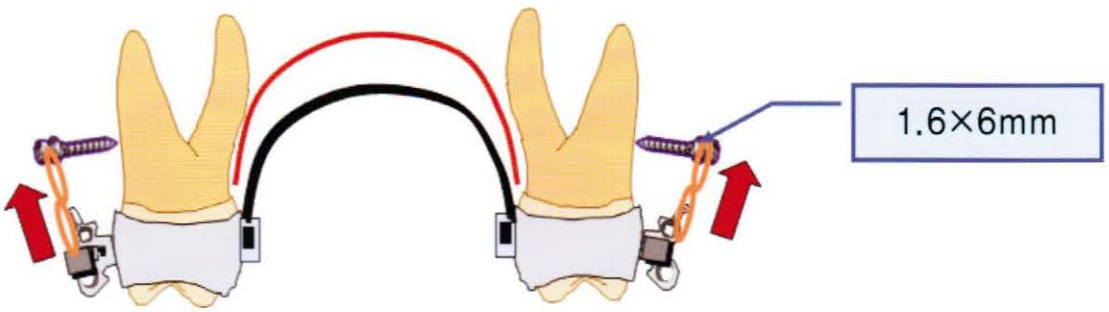
Advantages

1. Mid-palatal mini-implants are very stable. Failure rate is low.

Disadvantages

1. Buccal mini-implants can fail, as in Method 1. With failure, continued intrusion is not possible.
2. Palatal structures may cause discomfort for the patient.
3. If hooks are bonded to the mini-implant head, removal of the appliance is difficult.

Method 4



This is a method using a TPA with crown lingual torque and two buccal mini-implants to intrude the molars.

Clinical tip ››››

- **Mini-implants**
  - Buccal : 1.6x6.0 between 6 and 7 2EA
- **Brackets**
  - Buccal : 022" MBT
  - Palatal : Palatal sheath
- **Wires**
  - Buccal : 019x025" ss or heavier
- **Palatal TPA 0.9mm ss**
- **Space more than 3mm are required between the TPA and the palatal mucosa. Otherwise, the TPA will impinge on the mucosa as the upper molars are intruded.**

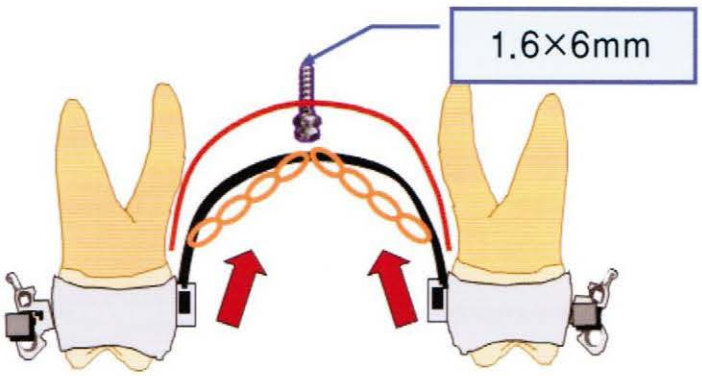
Advantages

1. Mid-palatal mini-implant is not required.

Disadvantages

1. Buccal mini-implant can fail, as in Method 1. With failure, continued intrusion is not possible.
2. Bucco-lingual control of the first molar is easy using TPA, but is difficult for the rest of the teeth (there are times when intrusion of the palatal cusp is required). A thick wire is needed in the buccal bracket.

Method 5



This is a method using a TPA with crown buccal torque and a midpalatal mini-implant to intrude the molars.

Clinical tip ››››

- **Mini-implants**
  - Mid-palatal : 1.6x6.0
    - On a line connecting the mesial openings of 6's palatal sheaths
- **Brackets**
  - Buccal : 022" MBT
  - Palatal : Palatal sheath
- **Wires**
  - Buccal : 019x025" ss or heavier with crown buccal torque
- **Palatal TPA with hooks : 0.9mm ss**
  - Space more than 3mm are required between the TPA and the palatal mucosa. Otherwise, the TPA will impinge on the mucosa as the upper molars are intruded.
  - If palatal cusps of the second molars and the bicuspids need to be intruded, hooks may be soldered to the TPA for intrusion.
  - A slight crown buccal torque is applied to the TPA.
  - TPA is expanded a little.

Advantages

1. Because the interradicular space between the first and second molars is usually narrow, it is difficult to find good cases for buccal mini-implant insertion. However with Method 5, it can be applied to most cases without the need for buccal implantation. This is the method most preferred by the author.

Disadvantages

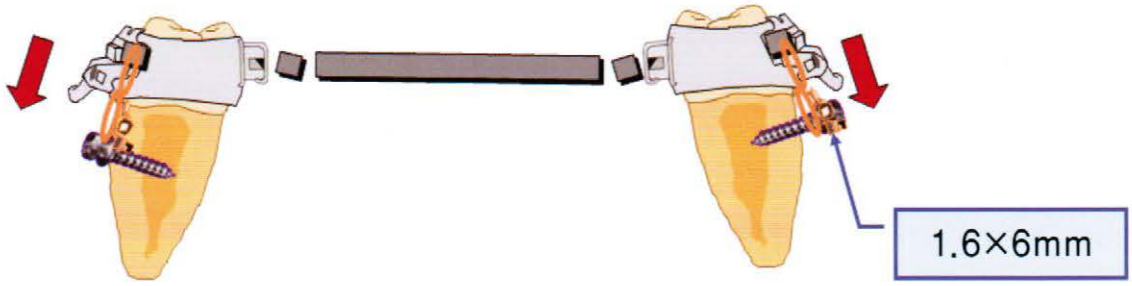
1. Crown buccal torque needs to be given to the thick buccal wire to prevent the palatal tilting which occurs with application of palatal intrusive force. This is not easy technically.

▶ **Refer to 〈Clinical tip for upper molar intrusion using Method 5〉 in Case 8 of Chapter 5, section B (Figure 5-4-13~17)**

Method of lower molar intrusion (Figure 5-1-6)

Intrusion of lower molars is difficult and the following method can be used.

Method 6



This is a method using Burstone lingual arch with lingual crown torque and buccal mini-implants to intrude the lower molars. Crown lingual torque is applied slightly to counteract the buccal tipping from the intruding force from the power chains.

Clinical tip ››››

■ **Mini-implants**

- Buccal : 1.6x6.0 between 6 and 7

■ **Brackets**

- Buccal : 022" MBT
- Lingual : Burstone lingual sheath

■ **Wires**

- Buccal : 019x025" ss or heavier

■ **Burstone lingual arch**

- Slightly constricted with crown lingual torque

Advantages

1. Open bite can be treated more effectively if lower molars are intruded together with the upper molars.

Disadvantages

1. Difficult to find good indications. There are not many cases where the interradicular distance between the first and second molar is wide enough. In these cases the mini-implant can be inserted between the second premolar and first molar, but it is not as effective. The mini-implants should be as far distally as possible for effective correction of open bite.
2. Mini-implant failure occurs fairly often with molar intrusion. The reason for this is that the mini-implant becomes closer to the alveolar crest with intrusion, and makes the space between roots narrower. This causes the mini-implant to be exposed to trauma from occlusal forces or tooth movement.
3. The attached gingiva is narrow, especially in the mandible compared to the maxilla. In other words because the mini-implant cannot be inserted close to the apex, it sits near the alveolar crest. Failure rate increases in these cases. In cases where the attached gingiva is narrow, the mini-implant can be inserted with an angle of around 30° towards the root apex instead of being perpendicular to the surface of bone.

Ⅱ. Open bite treatment

This will be explained using Method 1 and Method 5 introduced in section B. All methods from Method 1 to 6 uses **segmented archwires** for sectional intrusion of molars for open bite treatment, or **continuous archwires** for molar intrusion together with incisor extrusion.

Clinical tip ››››

Segmented archwire or continuous archwire?

★ Segmented archwire

Characteristics : treatment of open bite by intrusion of molars only (Case 6)

Indications :

1. Incisor display at rest and smile is normal or excessive, and any more incisor extrusion is unesthetic.
2. Lip incompetency : the lips are parted at rest. The muscles around the mouth show tension during mouth closing.
3. Lower anterior facial height is relatively large.
4. There is a compensating curve in the upper arch. The posterior occlusal plane sits lower than the anterior occlusal plane.

★ Continuous archwire

Characteristics : some molar intrusion is required, and some incisor extrusion is allowed (Case 7)

Indications :

1. Incisor display during rest or smile is lacking and some incisor extrusion will be esthetically favorable.
2. Even though lip incompetency exists, there is less muscle tension on mouth closing. It is possible to improve this area through mandible autorotation.
3. Lower anterior facial height is slightly large.
4. The compensating curve in the upper arch is not severe.

(1) Sectional intrusion of upper molars using segmented archwires

The following case uses Method 1 for molar intrusion.

■ Case 6 (Figure 5-2-1 to 18)

- Age : 32 years 3 months
- Sex : female
- Chief complaint : open bite, mouth protrusion

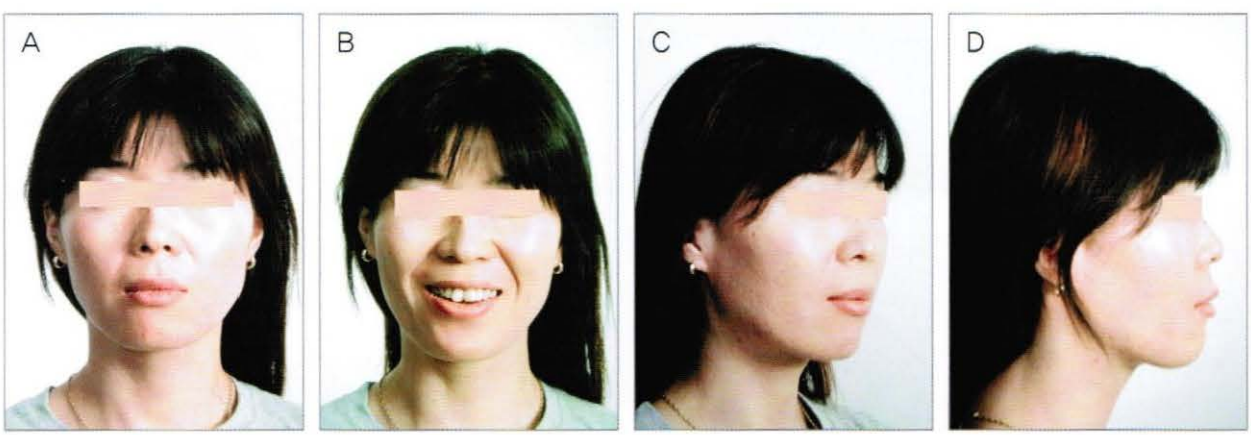
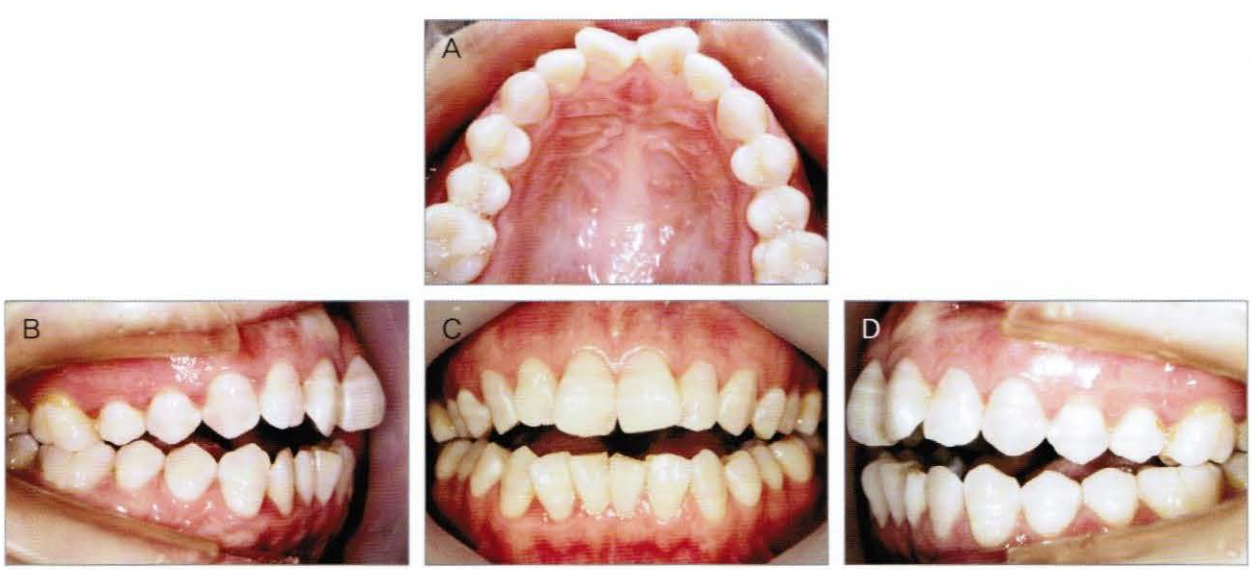


Figure 5-2-1. Pre-treatment facial photograph of Case 6
She shows mouth protrusion and large display of teeth on smiling. The muscles around the mouth are tensed during mouth closure.



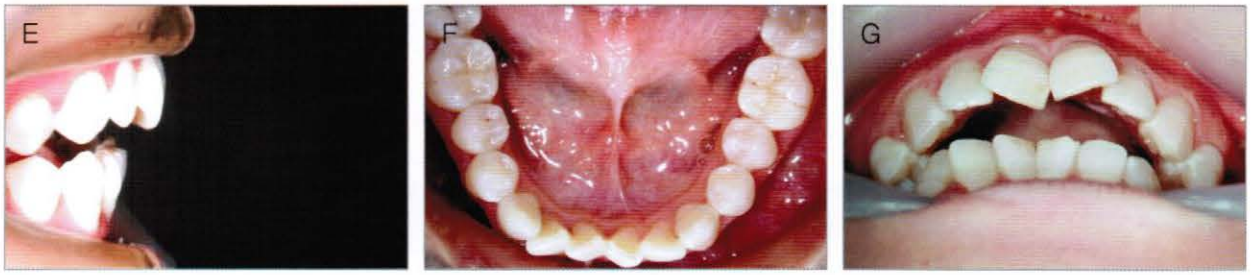
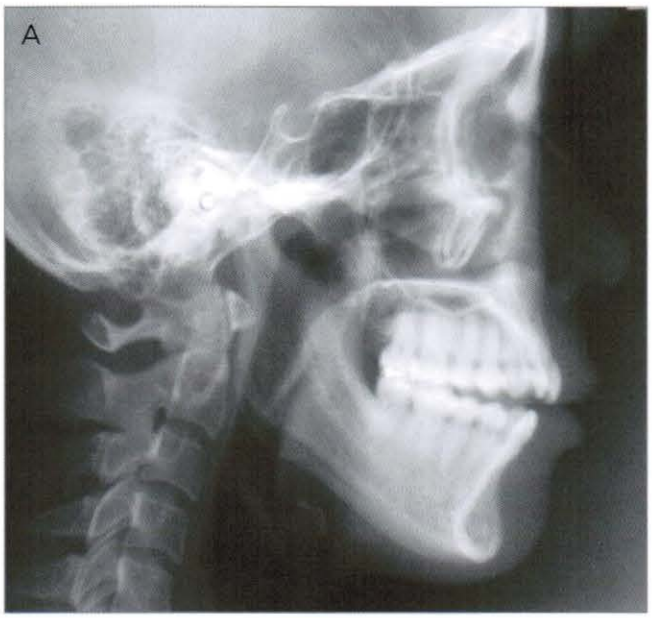
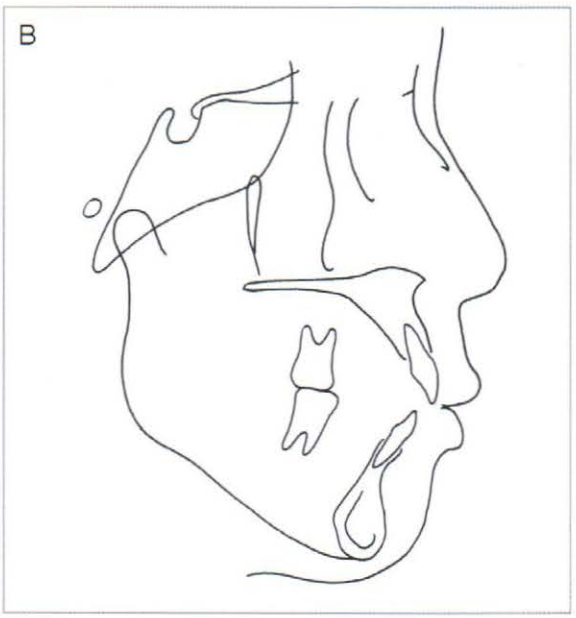


Figure 5-2-2. Pre-treatment intraoral photographs of Case 6
The upper arch is crowded (A, F). Open bite is severe (C), and the overjet is also large (E, G). There is a reverse curve in the upper arch, and the lower arch also shows a reverse curve of Spee (B, D). Note the steps between the mesial marginal ridge of the upper first molar, and the distal marginal ridge of the second premolar (B, D).





C

	Norm	SD	T1
SNA	81.6	3.2	79.4
SNB	79.2	3.0	75.1
ANB	2.5	1.8	4.3
FMA	24.3	4.6	30.3
U1 to FH	116.0	5.8	111.0
IMPA	95.9	6.4	93.9
IIA	123.8	8.3	124.9
Esth-U	-0.9	2.2	2.7
Esth-L	0.6	2.3	3.0

Figure 5-2-3. Pre-treatment cephalometric radiograph (A) and tracing (B), and measurement (C)
A. She shows characteristics of Skeletal Class II open bite.
B, C. ANB of 4.3°, and FMA of 30.3° are larger than normal.

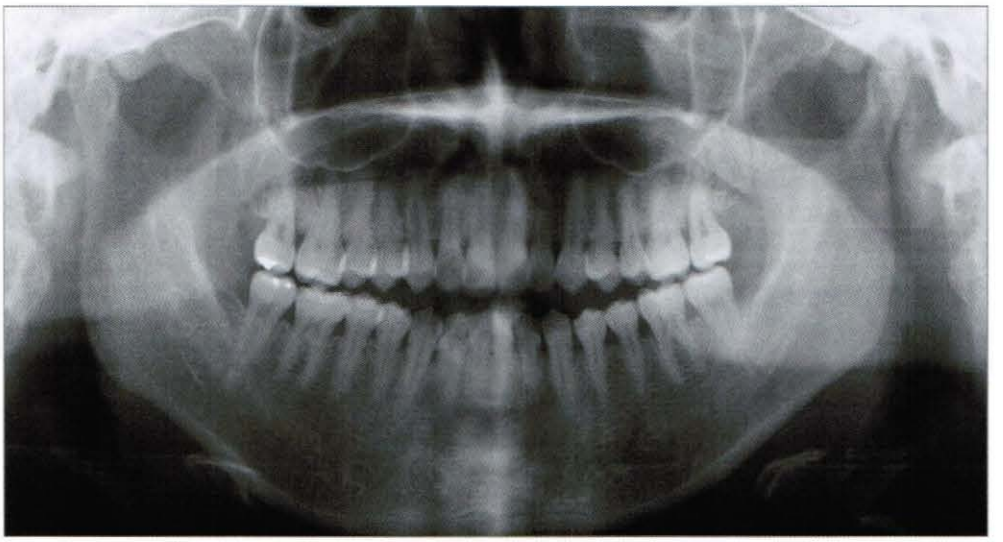


Figure 5-2-4. Pre-treatment panoramic radiograph
The upper first and second molars show slight extrusion. There is no pneumatization of the maxillary sinus. On MRI, there is no disk displacement or other abnormalities.

Figure 5-2-5. Pre-treatment maxillary occlusal plane
There are steps between the mesial marginal ridge of the upper first molar, and the distal marginal ridge of the second premolar. By intrusion of the upper molars which act as a wedge, treatment of open bite can be expected.

Treatment Progress

- **Implantation**
  - 2001. 8.23 — Buccal 1.2×8.0 — 2EA 7↓6|6↓7
    Palatal 2.0×10.0 — 2EA 7↓6|6↓7
  - 2001. 11.29 — Re-implantation — |5↓6 (Failure of |6↓7)
- **Intrusion of upper molars** — 3 months
  - 2001. 12.4 ~ 2002. 3.14 — Segmental intrusion of upper molars
  - 2002. 4.30 — Extraction of four first bicsupids
- **Leveling** — 4 months
  - 2002. 5.15 — 014″ NiTi (except upper and lower incisors)
  - 2002. 5.28 — 016″ NiTi
  - 2002. 6.19 — 018″ NiTi
  - 2002. 7.10 — 016×022″ NiTi
- **Canine retraction** — 6 months
  - 2002. 8.7 ~ 2003. 2.5 — 018×022″ ss
- **Leveling** — 4 months
  - 2003. 2.5 — Bonding brackets on upper and lower incisors
    U : 014″ NiTi — L : 014″ NiTi
  - 2003. 3.26 — U : 018″ NiTi
  - 2003. 5.28 — U : 016×022″ NiTi — L : 016″ NiTi
  - 2003. 6.25 — L : 016×022″ NiTi
- **Space closing** — 12 months
  - 2003. 9.19 ~ 2004. 9.25 — U/L : 018×022″ ss with shoe hooks
    Class I 5/16″ 6oz elastics
- **Detailing** — 5 months
  - 2004. 9.25 — U : 019×025″ ss with shoe hooks
    (crown labial torque)
- **Debonding**
  - 2005. 2.22

As this was one of the early mini-implant patients, surgical bone screws were used (these days, buccal 1.6x6.0mm, and palatal 1.6x8.0mm mini-implants are being used). These implants were inserted with drilling, and much time was expended with failure and re-insertion of implants. A fair amount of molar intrusion was achieved over 4 months. Treatment time was lengthened due to long appointment intervals due to patient circumstances.

Figure 5-2-6. Mechanism for upper molar intrusion
A. Illustration B. Upper right buccal
C. Upper left buccal D. Upper right palatal
E. Upper left palatal

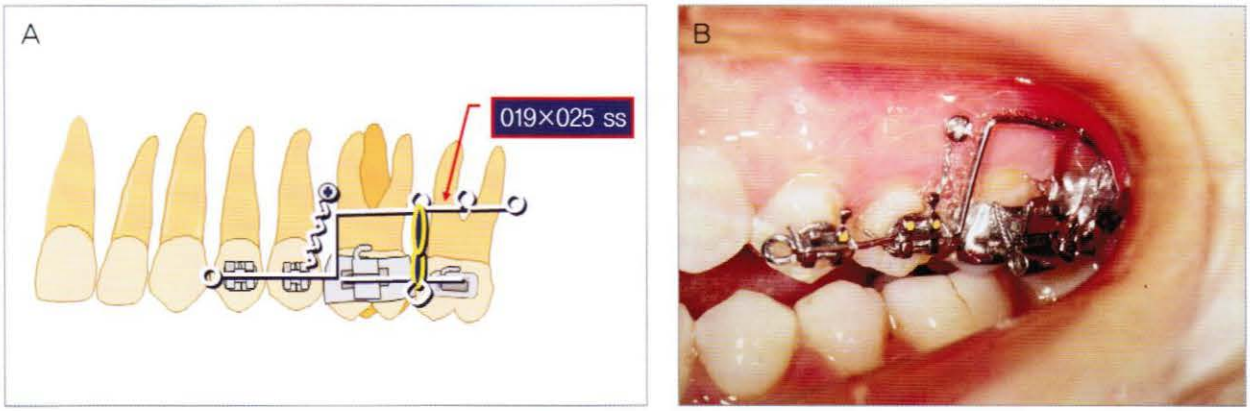


Figure 5-2-7. Failure of upper left buccal screw
A. Screw has been re-implanted between the second premolar and first molar. The screw head and second premolar bracket have been tightly ligated with ligature wire. 019×025" ss wire is bent as shown in the diagram.
B. Actual application in the patient.

Clinical tip ››››

What measures should be taken when mini-implants fail?

1. Keep in mind that 1 out of 20 fail. This must also be explained to the patient before the procedure.
   - Around 1 out of 10 failed in the early days of mini-implant use, but the failure rate is now lower.
   - More fail during molar intrusion.
2. When mini-implants fail, find an alternative area for insertion, and new mechanics are designed.
3. If there are no alternative methods, treatment must be continued using conventional mechanics. The patient must be informed that orthognathic surgery may be required.

Figure 5-2-8. Intraoral photographs before intrusion (2001. 12.4)

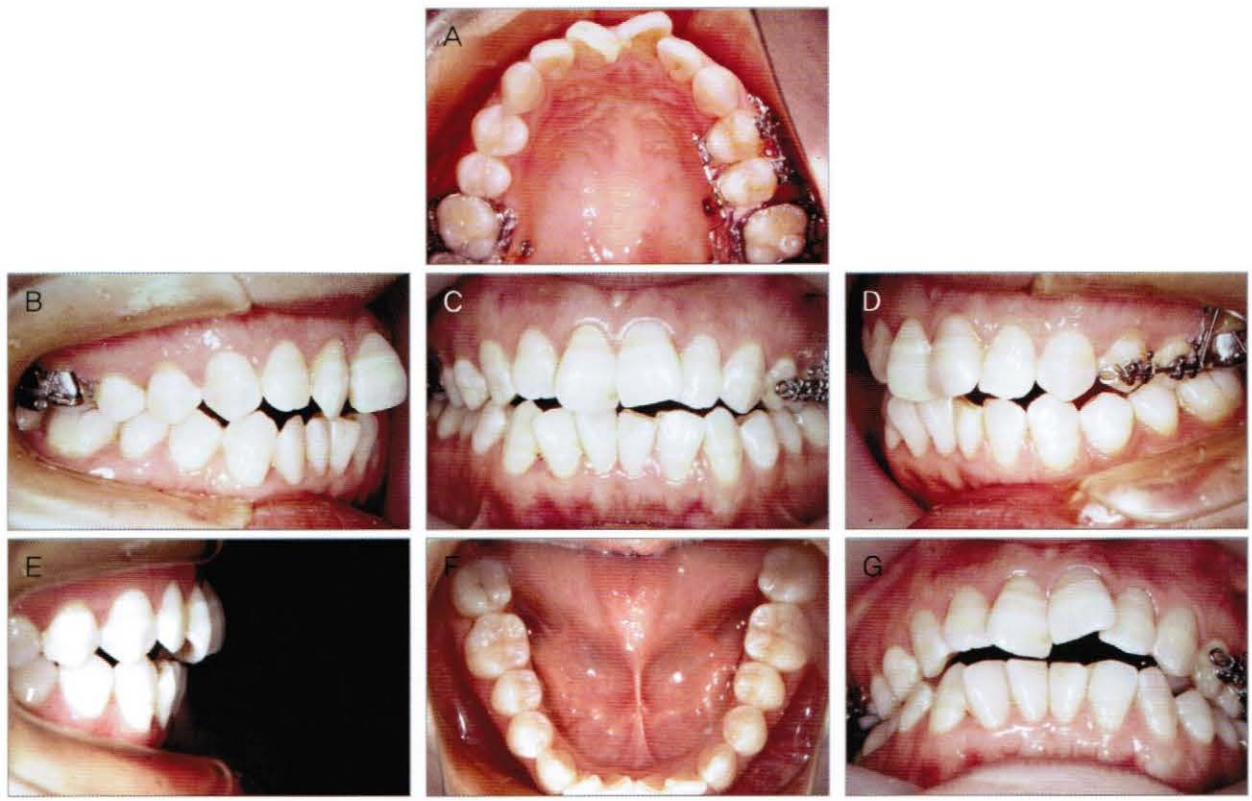
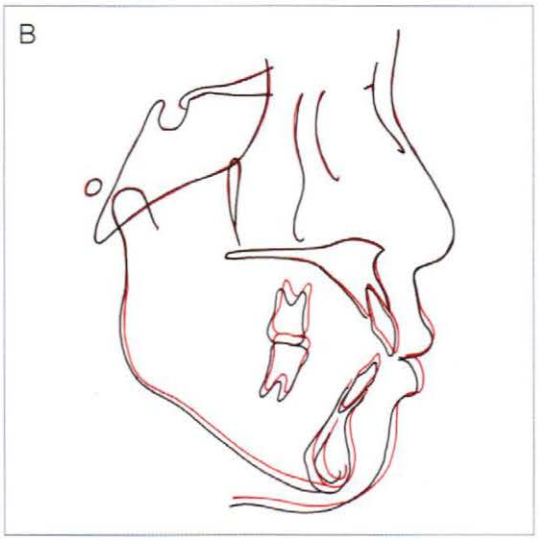


Figure 5-2-9. Intraoral photographs 4 months after intrusion of upper molars (2002. 3.14)
Anterior open bite has been resolved without any extrusion of incisors (C). Overjet has also decreased (E, G).



C

	Norm	SD	T1	T2
SNA	81.6	3.2	79.4	78.9
SNB	79.2	3.0	75.1	75.5
ANB	2.5	1.8	4.3	3.5
FMA	24.3	4.6	30.3	27.9
U1 to FH	116.0	5.8	111.0	111.7
IMPA	95.9	6.4	93.9	94.5
IIA	123.8	8.3	124.9	124.9
Esth-U	-0.9	2.2	2.7	2.4
Esth-L	0.6	2.3	3.0	4.6

Figure 5-2-10. Cephalometric radiograph and measurement after 4 months of upper molar intrusion (2002. 3.14)

A. Compare with the pre-treatment cephalometric radiograph (Figure 5-2-3A). Even with the naked eye, it can be seen that the ope bite and overjet have decreased from only upper molar intrusion.

B. Upper molar intrusion has allowed the mandible to be autorotated anticlockwise. Black line indicates pre-treatment, and the red lir is after intrusion.

C. FMA has decreased from 30.3° to 27.9° ANB has decreased from 4.3° to 3.5°.

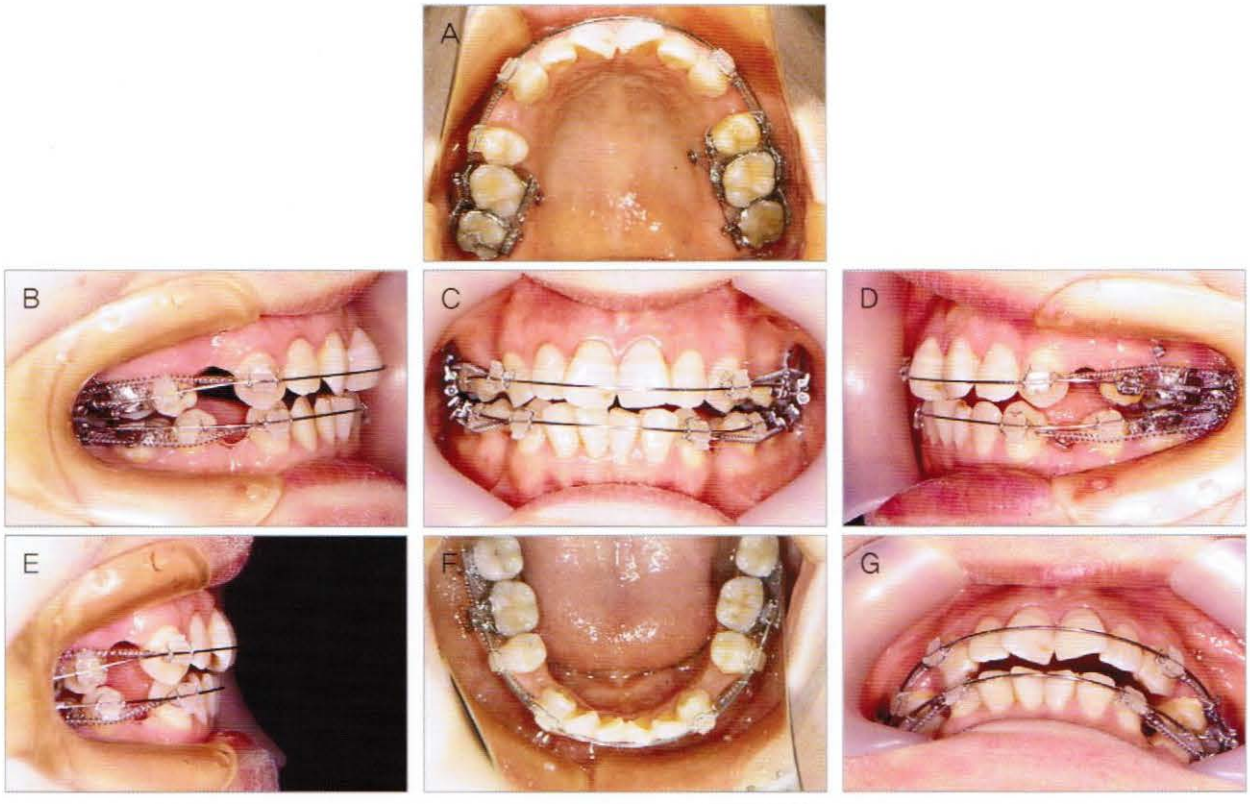


Figure 5-2-11. Leveling with brackets bonded from canine to second molar (2002. 8.21)
While the upper and lower incisors were not bracketed, relief of crowding in the incisors occurs naturally.

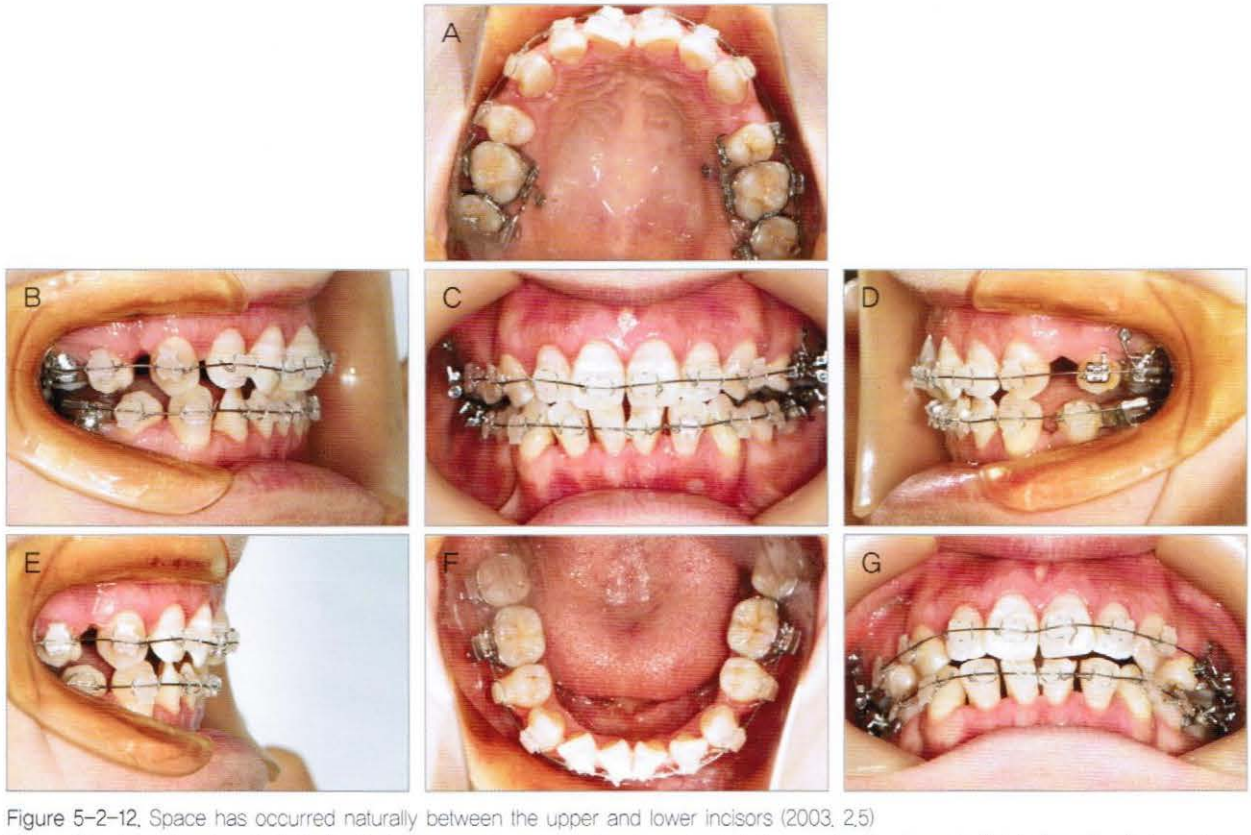


Figure 5-2-12. Space has occurred naturally between the upper and lower incisors (2003. 2.5)
Even without bonding brackets in the incisors, spaces occur naturally and relief of crowding is allowed. At this time, the incisors have been bracketed for alignment.

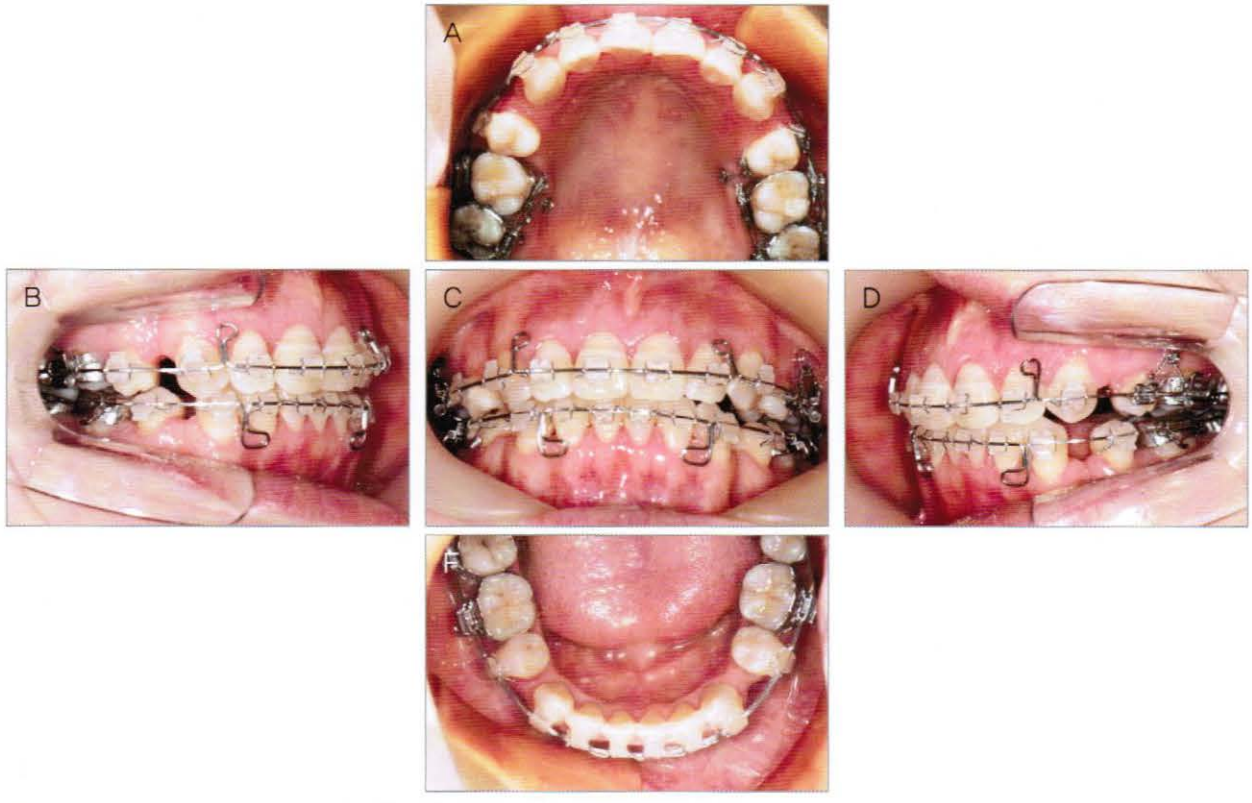


Figure 5-2-13. Space closure stage (2003. 12.3)
018×022" ss with shoe hooks and 5/16" 6 oz elastics are used for space closure. Ligature wire has been tightly ligated between the screw head and upper molar bracket to prevent relapse.

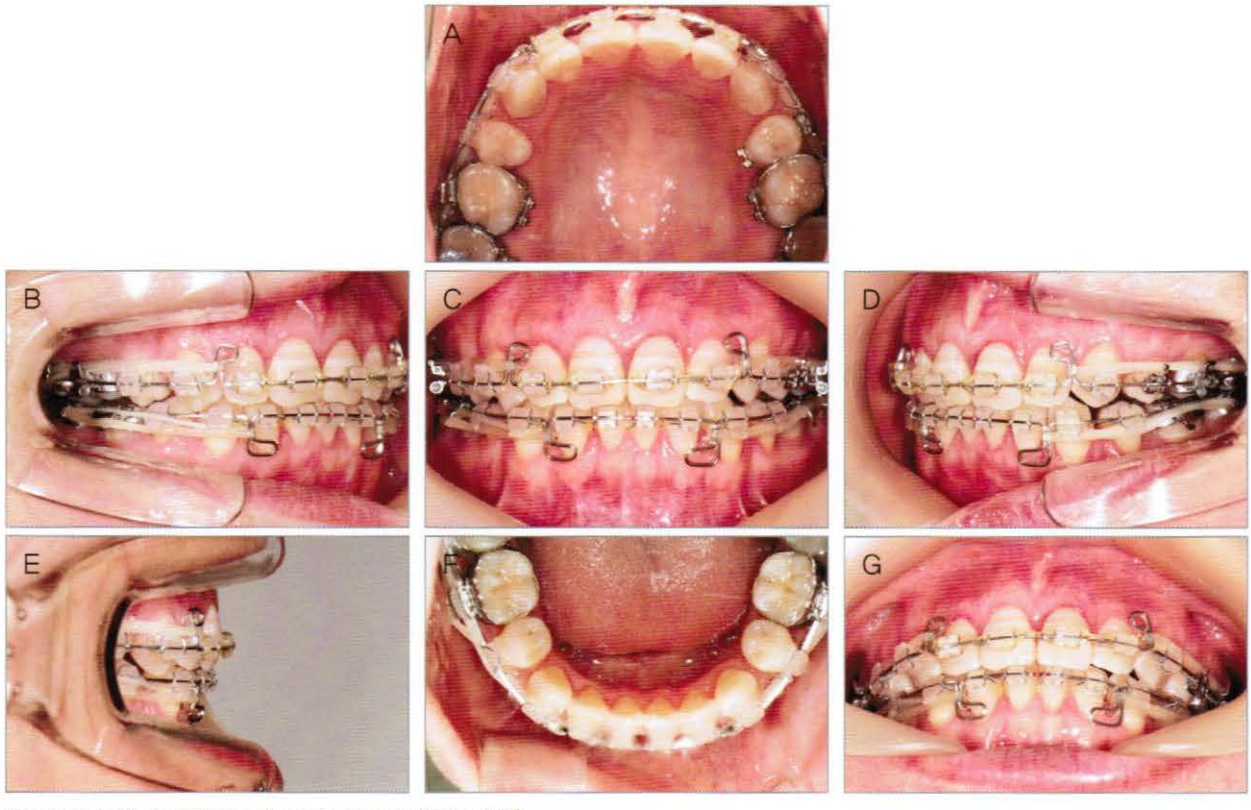


Figure 5-2-14. Completion of space closure (2004. 9.25)

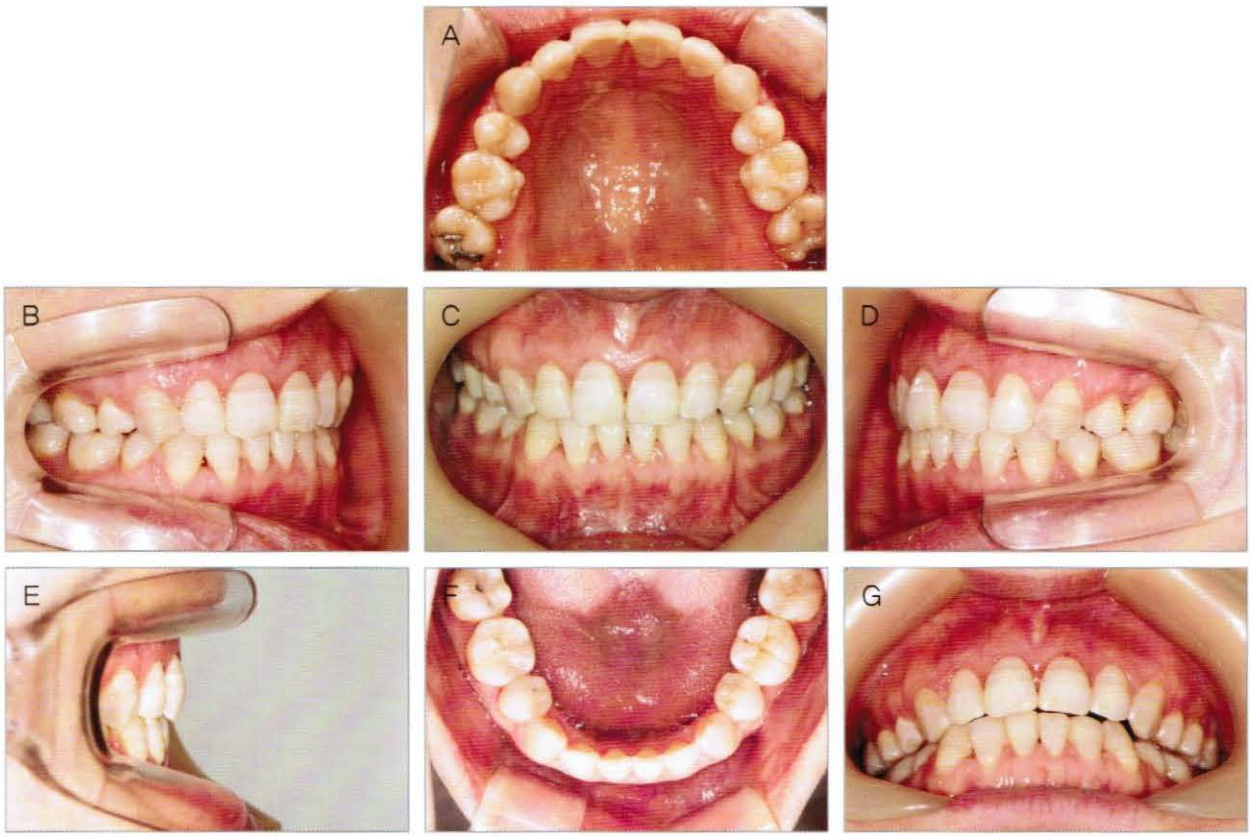


Figure 5-2-15. Intraoral photographs at debonding (2005. 5.22)

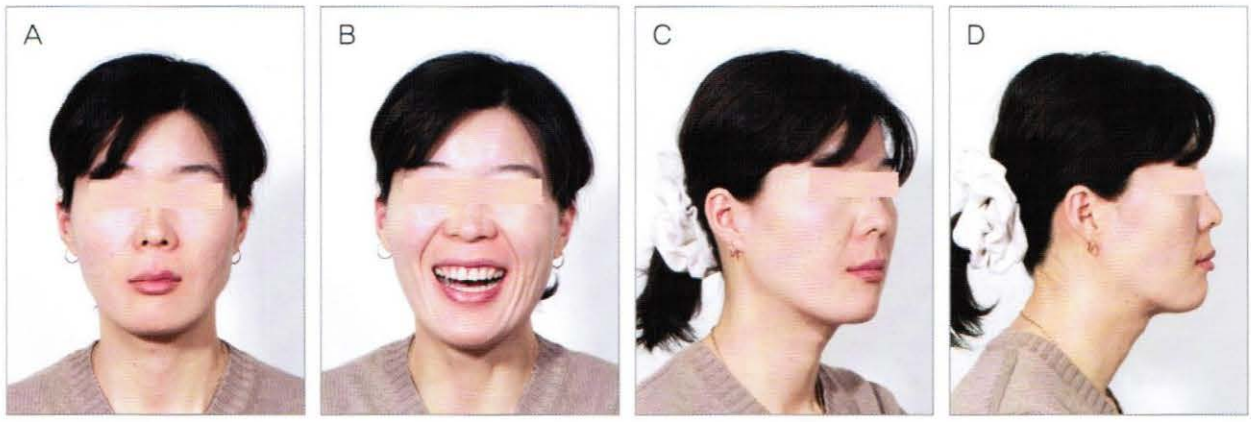
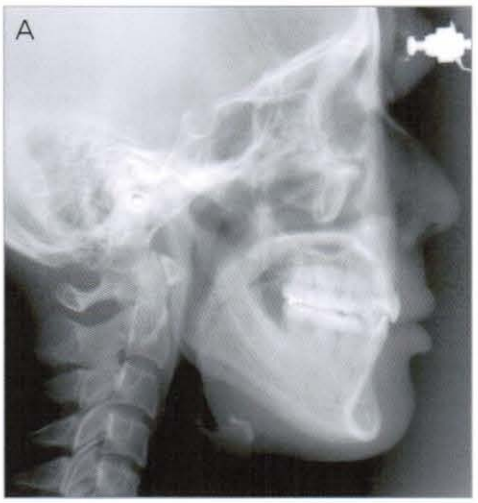
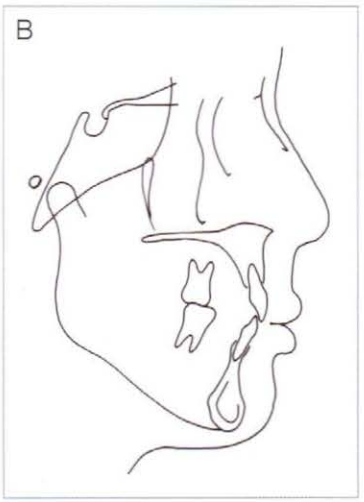
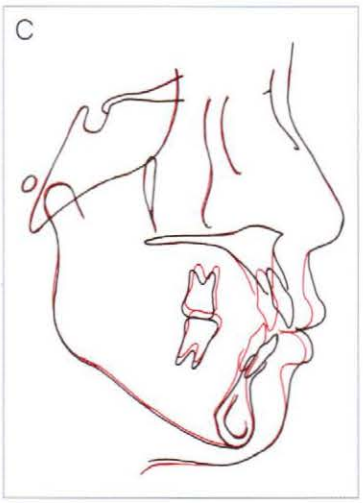
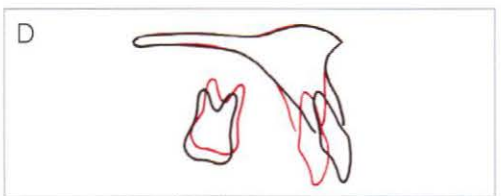


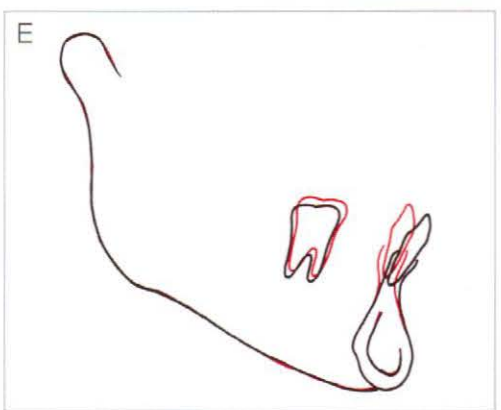
Figure 5-2-16. Facial photographs at debonding (2005. 5.22)











F

	Norm	T1	T2	T3
SNA	81.6	79.4	78.9	79.0
SNB	79.2	75.1	75.5	76.0
ANB	2.5	4.3	3.5	3.0
FMA	24.3	30.3	27.9	28.0
U1 to FH	116.0	111.0	111.7	99.0
IMPA	95.9	93.9	94.5	82.4
IIA	123.8	124.9	124.9	147.4
Esth-U	-0.9	2.7	2.4	-0.3
Esth-L	0.6	3.0	4.6	1.3

Figure 5-2-17. Cephalometric radiograph and measurement at debonding (2005. 5.22)

A. Post-treatment cephalometric radiograph

B. Post-treatment cephalometric tracing

C. Pre-treatment and post-treatment superimposition
Profile has been improved. With anticlockwise rotation of the mandible, pogonion has moved forward.
Black line is pre-treatment and red lines is post-treatment

D. The upper and lower incisors have been retracted but the axis is well maintained. The upper first molars have been intruded.

E. There has been extrusion of the lower first molars.

F. Measurement.
T1 : pre-treatment, T2 : after sectional intrusion of the upper molars, T3 : post-treatment
FMA has been decreased and maintained well. ANB has decreased from 4.3° to 3.0°. Mouth protrusion has been relieved.

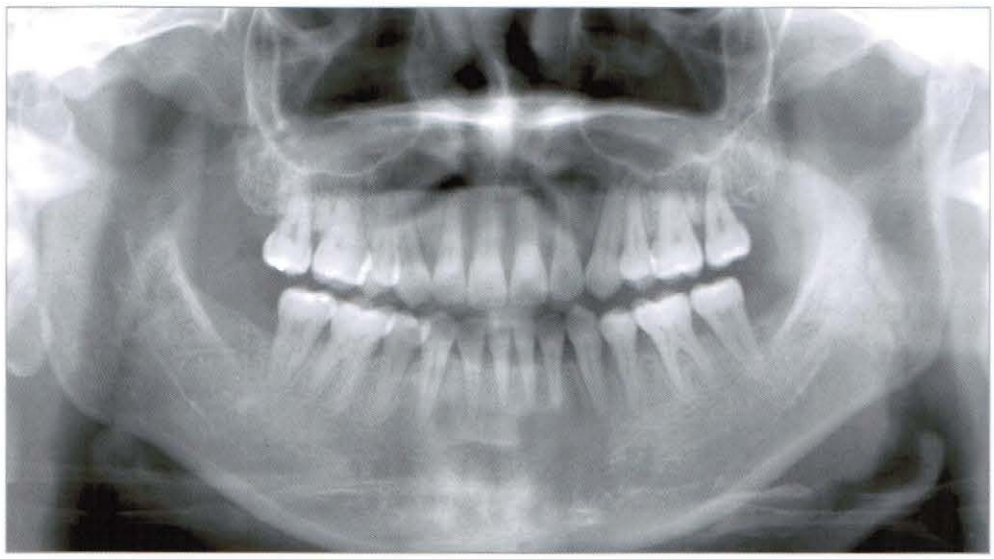


Figure 5-2-18. Panoramic radiograph at debonding
Except for general lowering of the alveolar bone, there are no problems such as root resorption.

■ Case 7 (Figure 5-3-1 to 21)

- Age : 27 years 7 months
- Sex : female
- Chief complaint : open bite, mouth protrusion

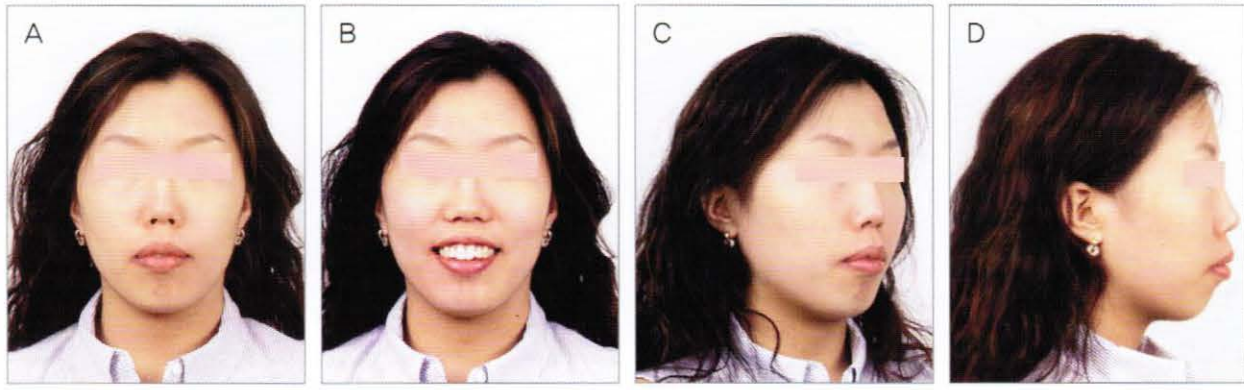


Figure 5-3-1. Facial photograph of Case 7
The mouth is protruded, and tooth exposure on smiling is greater than normal. There is muscle strain on mouth closure. The chin looks retruded. The nasolabial angle is small. Mouth protrusion makes the nose look relatively small.

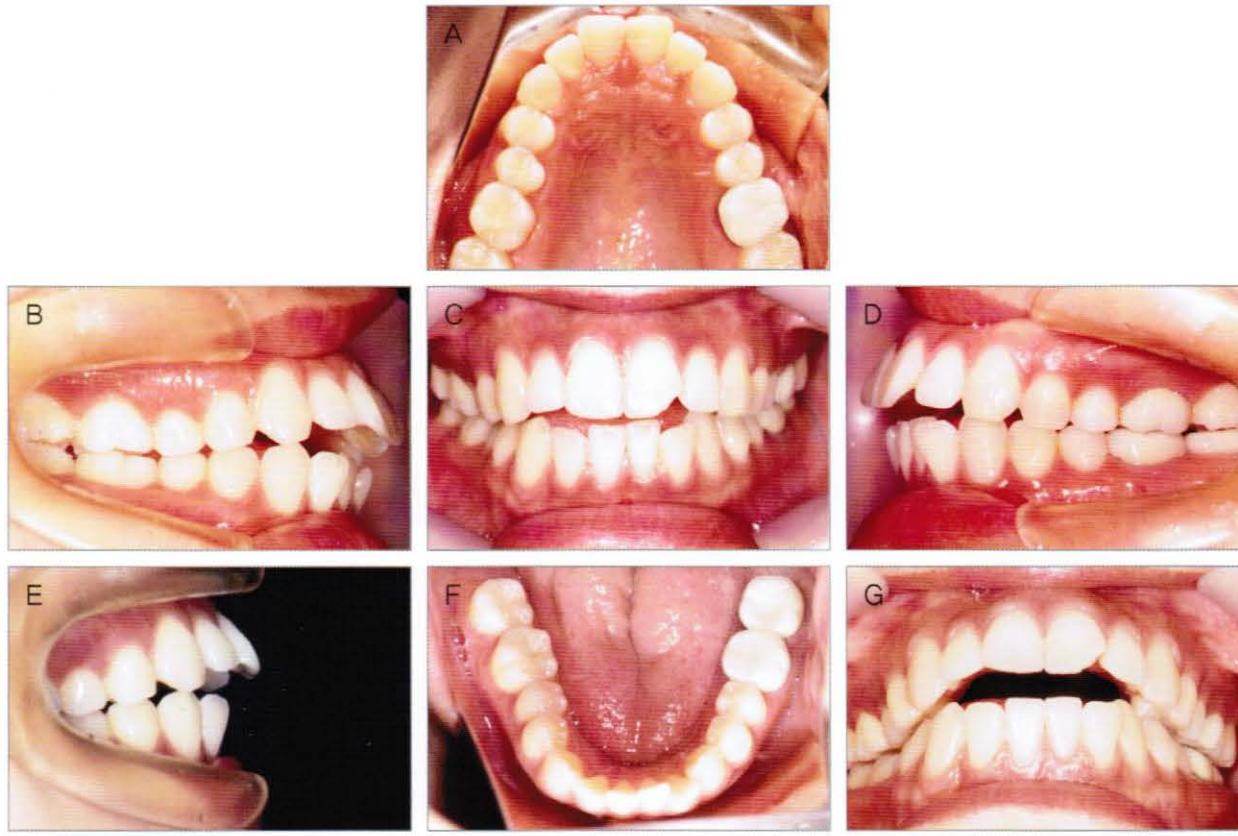


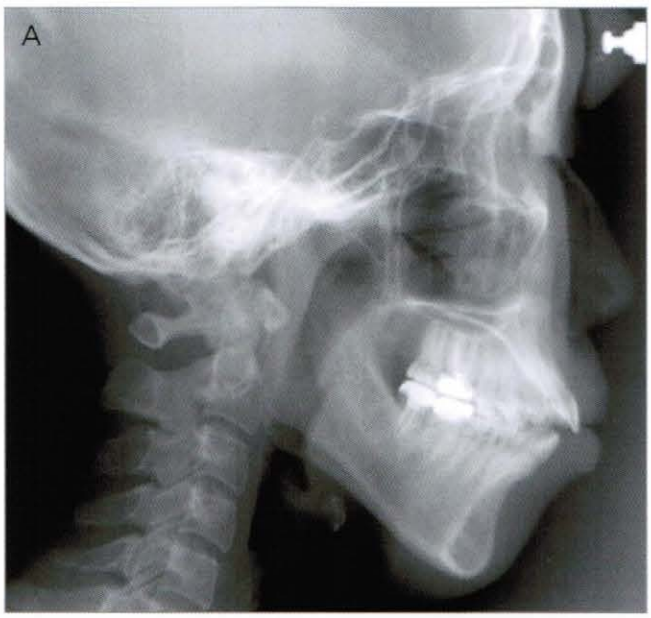
Figure 5-3-2. Intraoral photograph of Case 7
Both sides show a dental Class II relationship, and open bite. The upper and lower arches show reverse curves.

Clinical tip ››››

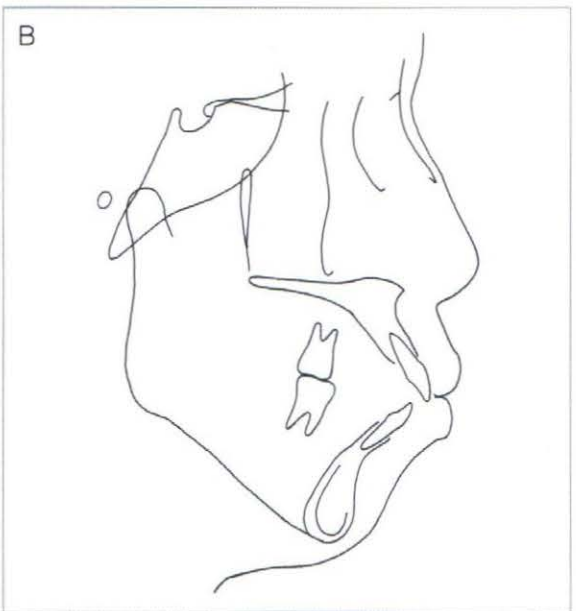
Don't always level with continuous archwires. Segmental wires can be used for molar intrusion in appropriate situations.

When the upper and lower arches have reverse curves, using continuous archwires can cause extrusion of the incisors. Therefore in gummy smile patients, the gummy smile can become worse. As shown in Case 7, segmented archwires are used first for molar intrusion, and continuous wires are then used to prevent incisor extrusion. Good results can be obtained.

A



B



C

	Norm	SD	T1
SNA	81.6	3.2	80.2
SNB	79.2	3.0	75.8
ANB	2.5	1.8	4.4
FMA	24.3	4.6	37.4
U1 to FH	116.0	5.8	117.2
IMPA	95.9	6.4	98.0
IIA	123.8	8.3	107.4
Esth-U	-0.9	2.2	7.3
Esth-L	0.6	2.3	9.4

Figure 5-3-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)

A. She shows a skeletal Class II open bite. It can be seen even on the radiograph that the muscles need to be tensed for mouth closure. She has lip incompetency.

C. ANB of 4.4°, and FMA of 37.4° are larger than normal.

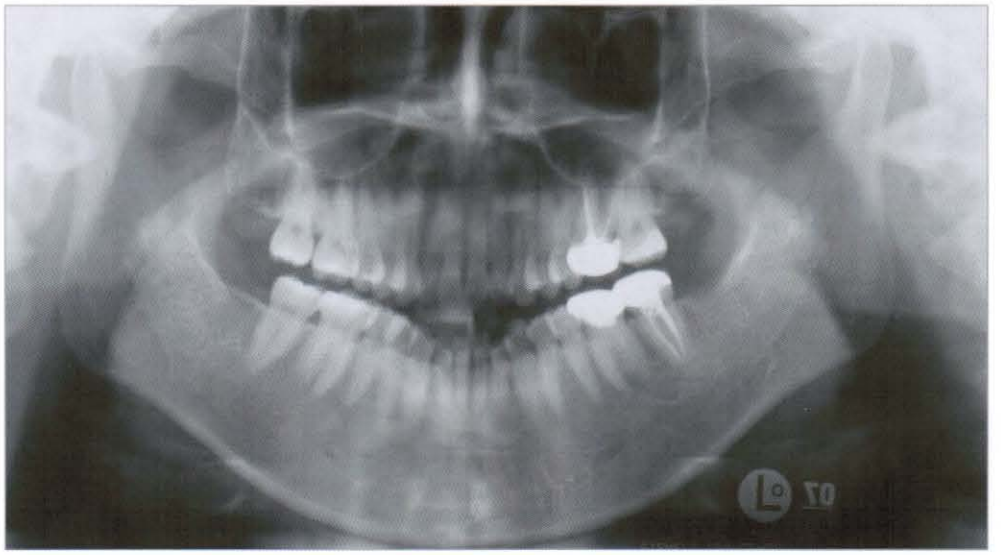
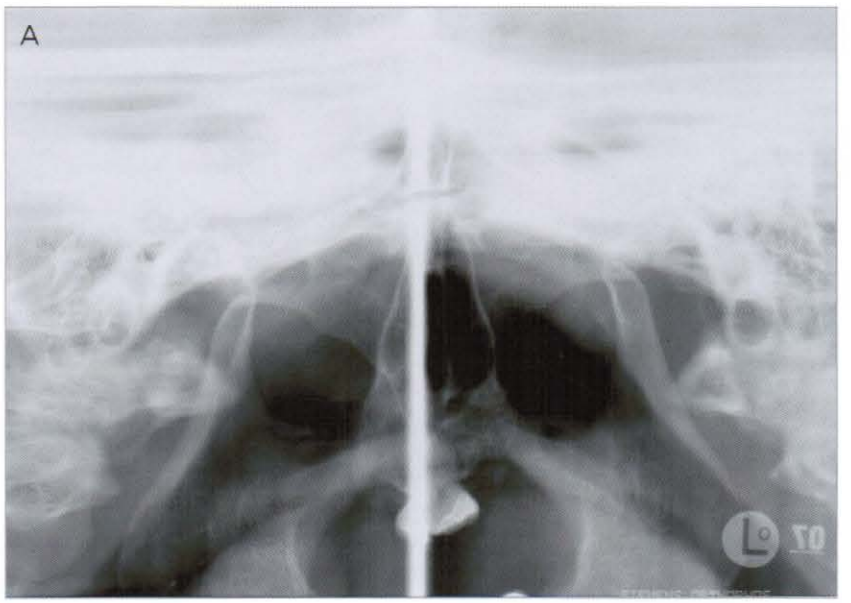


Figure 5-3-4. Pre-treatment panoramic radiograph
The condyles have normal anatomy.



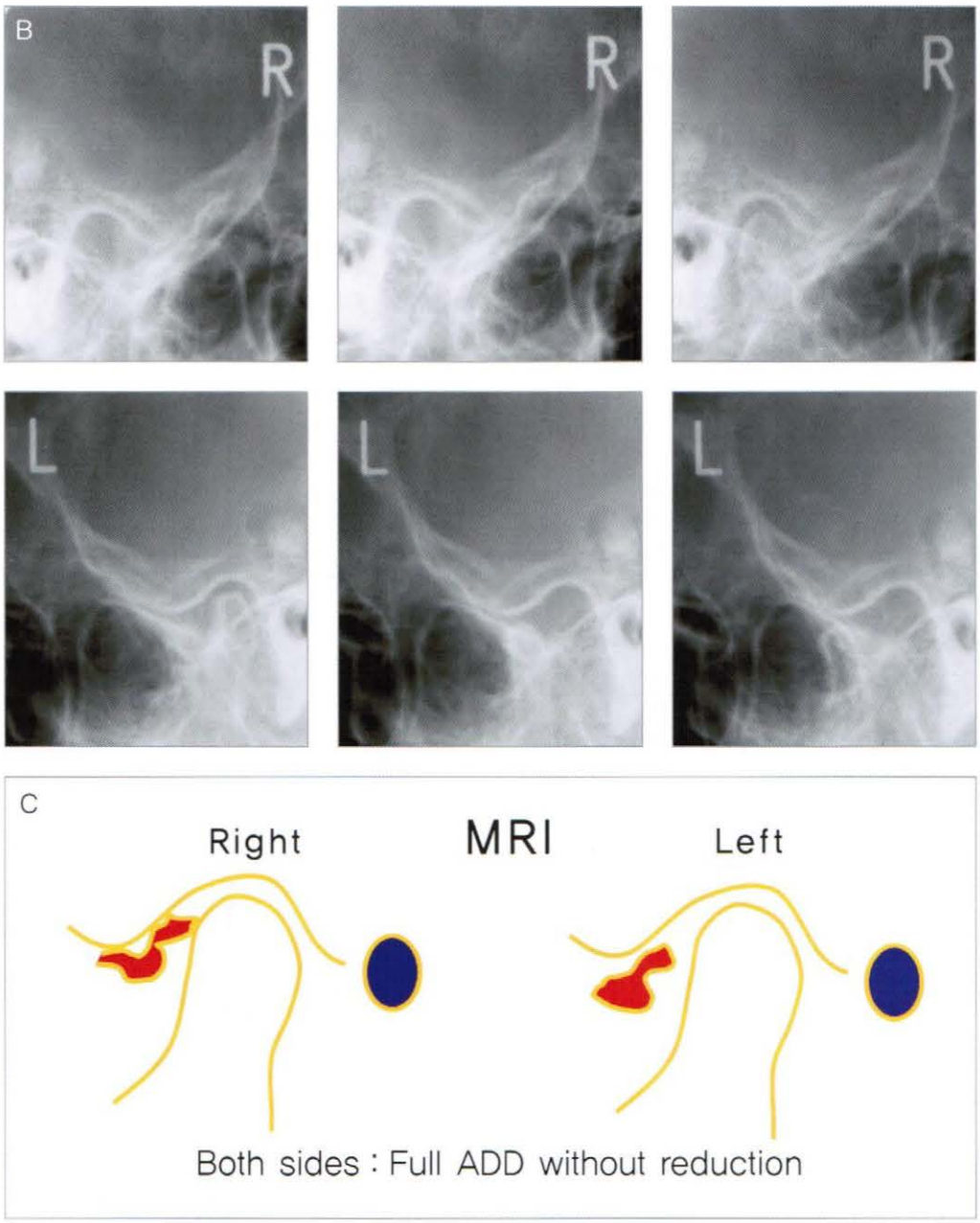


Figure 5-3-5. Pre-treatment screening of temporomandibular joint
A. TMJ panoramic radiograph. The condyle shapes of both sides are normal.
B. Transcranial radiograph. Closed, 1-inch open, and maximal opening all show normal anatomy.
C. On MRI, both sides showed full ADD (anterior disk displacement) without reduction

Clinical tip ››››

Class II open bite and TMJ disorders

The author has taken MRI for Class II open bite patients for the last 15 years. Out of these, around 70% showed disk displacement. If the TMJ disorder becomes worse, the Class II open bite can also become worse, and cause difficulties with orthodontic treatment or cause relapse.

Because the skeletal Class II is severe, it was explained to the patient prior to treatment that orthognathic surgery was a possibility. Before making a decision on extractions, segmental wires are used to intrude the molars. At this stage through re-examination, it was decided to extract the first premolars. In such a case, the upper first premolar and lower second premolar can be extracted considering the molar Class II relationship. A case treated in such a way will be introduced in the next case. Comparing the results of these 2 cases, a better result was obtained when mini-implants were used. Treatment time : 1) Intrusion (5 months), 2) incisor retraction and torque application (17 months), 3) and a long detailing stage (9 months) caused the treatment to take longer than other cases. Refer to the clinical tip section for reasons for a long detailing stage.

Clinical tip ››››

Detailing stage for open bite patients should take at least 6 months to a year.

1. Form a correct and comfortable occlusion.
2. Removable or fixed retainers will not be of much help in open bite patients. It cannot stop the molars from extruding. With fixed appliances in place, up and down elastics (3/16" 6 oz) are used between the upper and lower incisors for 8~12 hours (decrease gradually when stable) to maintain the overbite. Treat this time as the actual retention period for open bite patients.
3. Resolve muscle and exercise problems at the detailing stage.
   Remove tongue thrust habit. Try to restore the biting frequency which is usually low in open bite patients. Instruct the patient to chew sufficiently during meals.
4. Make sure that there are no TMJ problems.

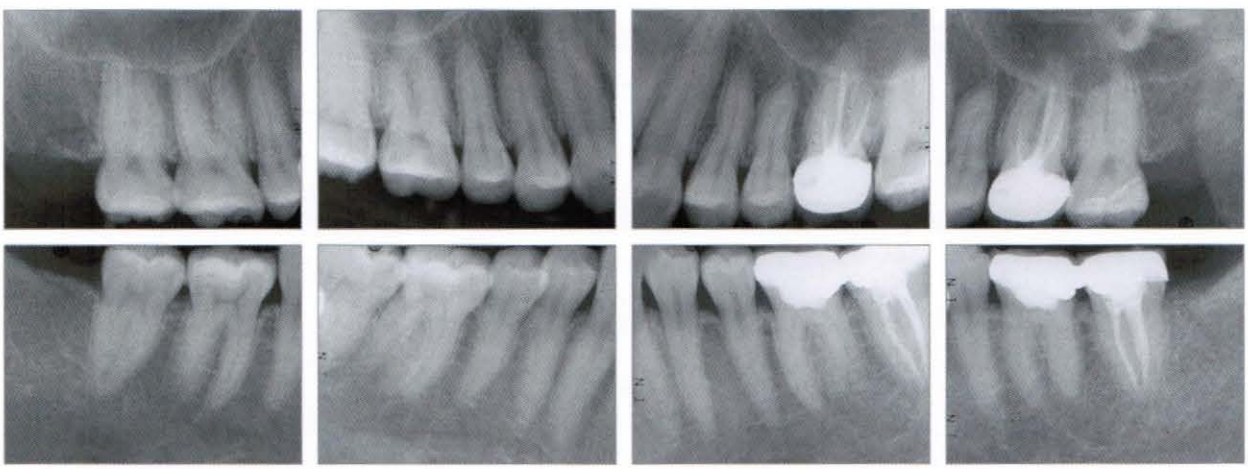


Figure 5-3-7. Periapical radiograph to check the distance between roots
Because the interradicular distance between the first and second molars is narrow, mini-implants were implanted between the first molar and second premolar.

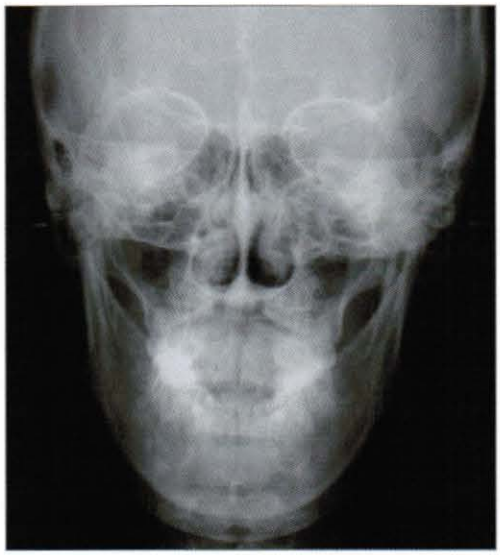


Figure 5-3-6. Pre-treatment postero-anterior radiograph
Shows no abnormalities.

Treatment Progress

- **Implantation & Intrusion of molars** — 5 months
  - 2003. 1.23 — Buccal : 1.6×6.0 4EA $\frac{6\downarrow 5|5\downarrow 6}{6\uparrow 5|5\uparrow 6}$
  - 2003. 2.4 — TPA + lower Burstone lingual arch 016×022″ TMA segmental wires
  - 2003. 2.6 — Re-implantation $\overline{5\uparrow 4|}$ (Failure of $\overline{6\uparrow 5|}$)
  - 2003. 5.27 — Extraction of four first bicuspids
- **Leveling** — 4 months
  - 2003. 6.24 — 014″ NiTi
  - 2003. 7.28 — U : 018″ NiTi L : 016″ NiTi
  - 2003. 8.18 — 016×022″ NiTi
  - 2003. 9.17 — 019×025″ NiTi
- **Anterior retraction** — 17 months
  - 2003. 10.14 — 019×025″ ss with shoe hooks
  - 2003. 11.12 — Removal of lower mini-implants
  - 2005. 4.12 — Removal of upper mini-implants
- **Detailing** — 9 months
  - 2005. 4.19 — U : 018×022″ ss with shoe hooks
- **Debonding**
  - 2006. 1.3

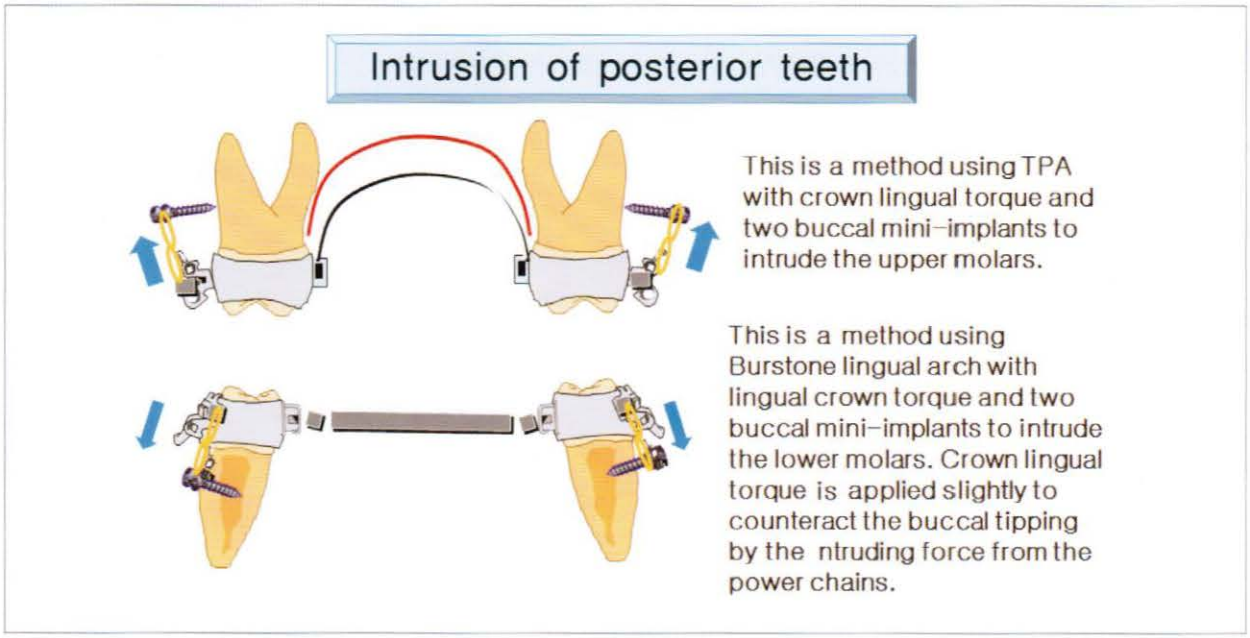


Figure 5-3-8. Method for intruding upper molars. Mehod 4 and Method 6 were used.
TPA with crown lingual torque was placed on upper first molars. If force is applied only from the buccal side, the crown may be tipped buccally. Crown lingual torque will stop this buccal tipping. A burstone lingual arch was inserted in the lower arch, also with lingual crown torque. A 1.6×6.0mm mini-implant was inserted between the second premolar and first molar. With segmental wire inserted from the first premolar to second molar, power chain or elastic thread is placed from the mini-implant to the wire for molar intrusion. The buccal segmental wire must be thick to prevent play in the bracket slot.

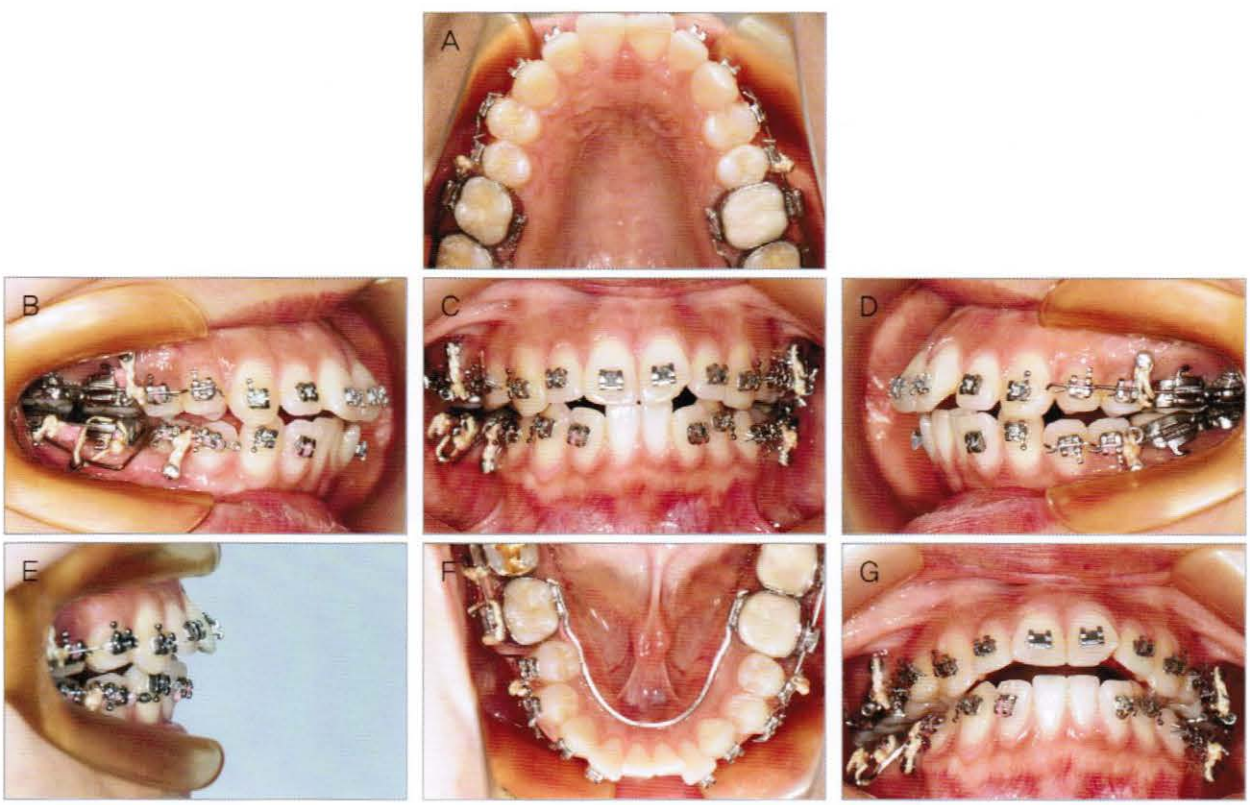


Figure 5-3-9. Intraoral photograph 4 months after molar intrusion (2003. 5.15)
Overbite has decreased with no extrusion of incisors (C). Overjet has also decreased (E, G).
Due to failure of the mini-implant between the lower right second premolar and first molar, a new mini-implant was inserted between the first and second premolar. But the efficiency of intrusion was decreased.

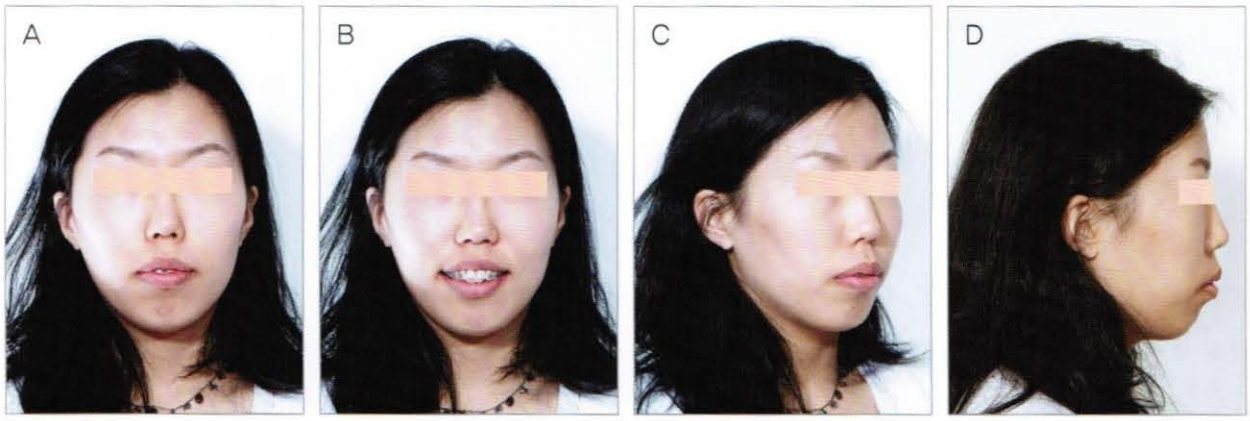
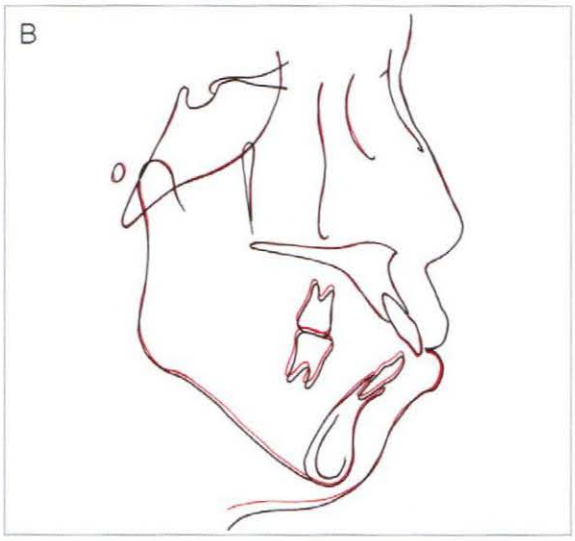
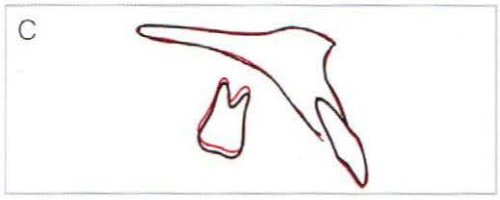
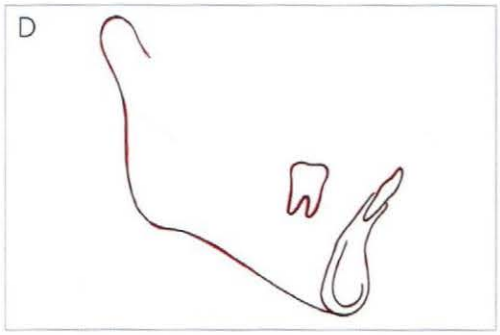


Figure 5-3-10. Facial photograph after 4 months of intrusion (2003. 5.15)







E

	Norm	SD	T1	T2
SNA	81.6	3.2	80.2	80.0
SNB	79.2	3.0	75.8	76.9
ANB	2.5	1.8	4.4	3.1
FMA	24.3	4.6	37.4	35.9
U1 to FH	116.0	5.8	117.2	117.2
IMPA	95.9	6.4	98.0	96.5
IIA	123.8	8.3	107.4	108.6
Esth-U	-0.9	2.2	7.3	7.8
Esth-L	0.6	2.3	9.4	10.9

Figure 5-3-11. Cephalometric radiograph after 4 months of upper molar intrusion (2003. 5.23) and measurement
A. Open bite and overjet have decreased with only molar intrusion.
B. Upper molar intrusion has allowed anticlockwise rotation of the mandible. Black line is pre-treatment and red line is after molar intrusion.
C. With superimposition of the maxilla, intrusion of the first molar can be confirmed.
D. The lower molars have not improved greatly.
E. FMA has decreased from 37.4° to 35.9°, ANB has decreased from 4.4° to 3.1°.

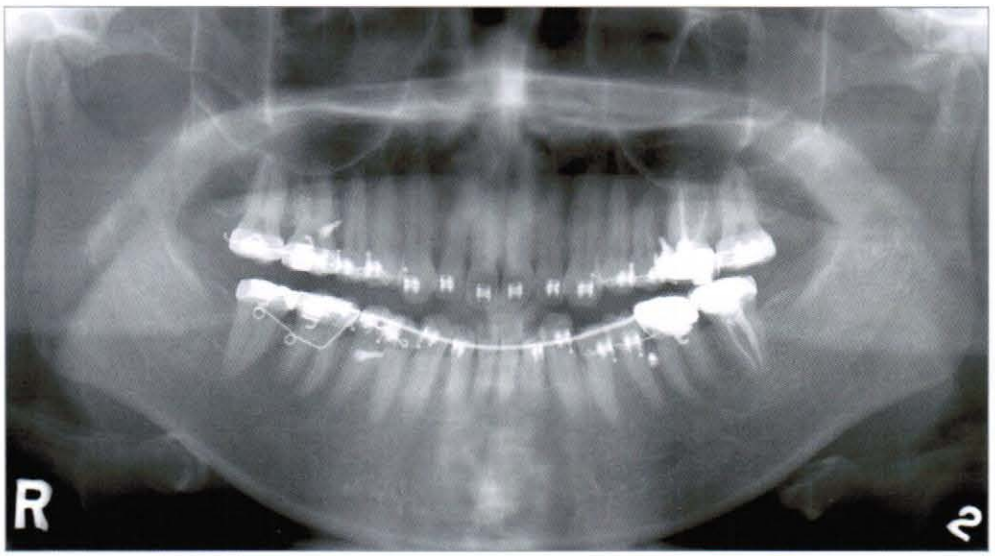


Figure 5-3-12. Panoramic radiograph taken during molar intrusion
No root resorption or other abnormalities can be seen.

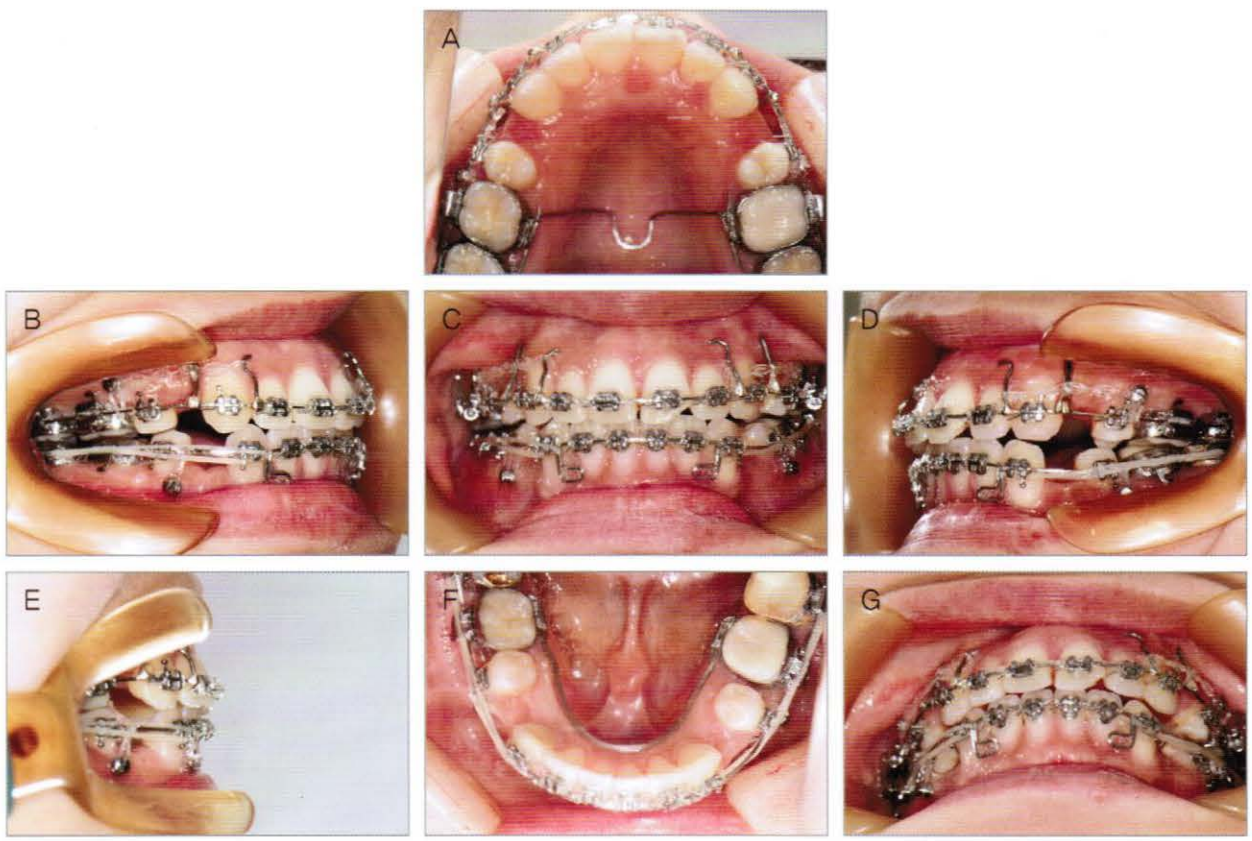


Figure 5-3-13. Intraoral photograph during retraction (2003. 11.3)
The incisors are being retracted using power chain and elastics (5/16" 6 oz). Molar intrusion was continued at this stage using power chain to the molars.

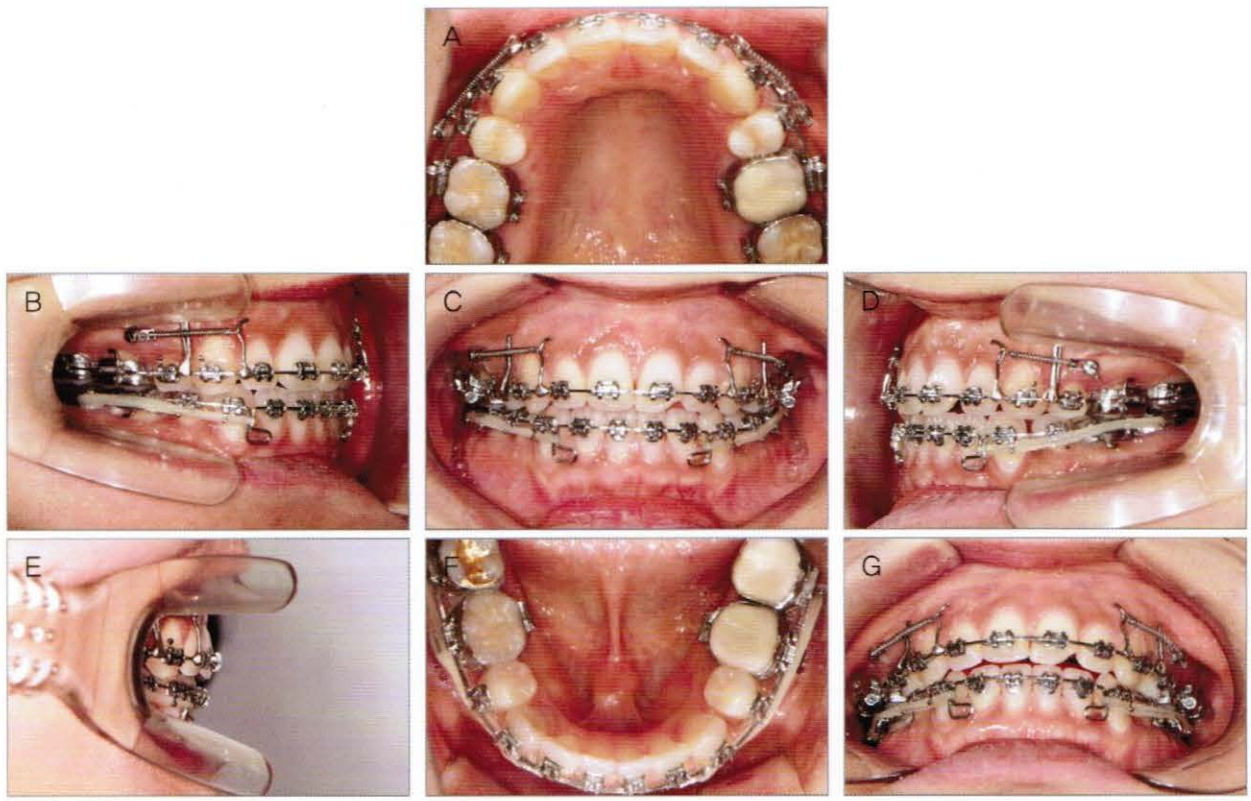


Figure 5-3-14. Last stage of space closure (2005. 1.13)
Lower mini-implant and Burstone lingual arch have been removed.

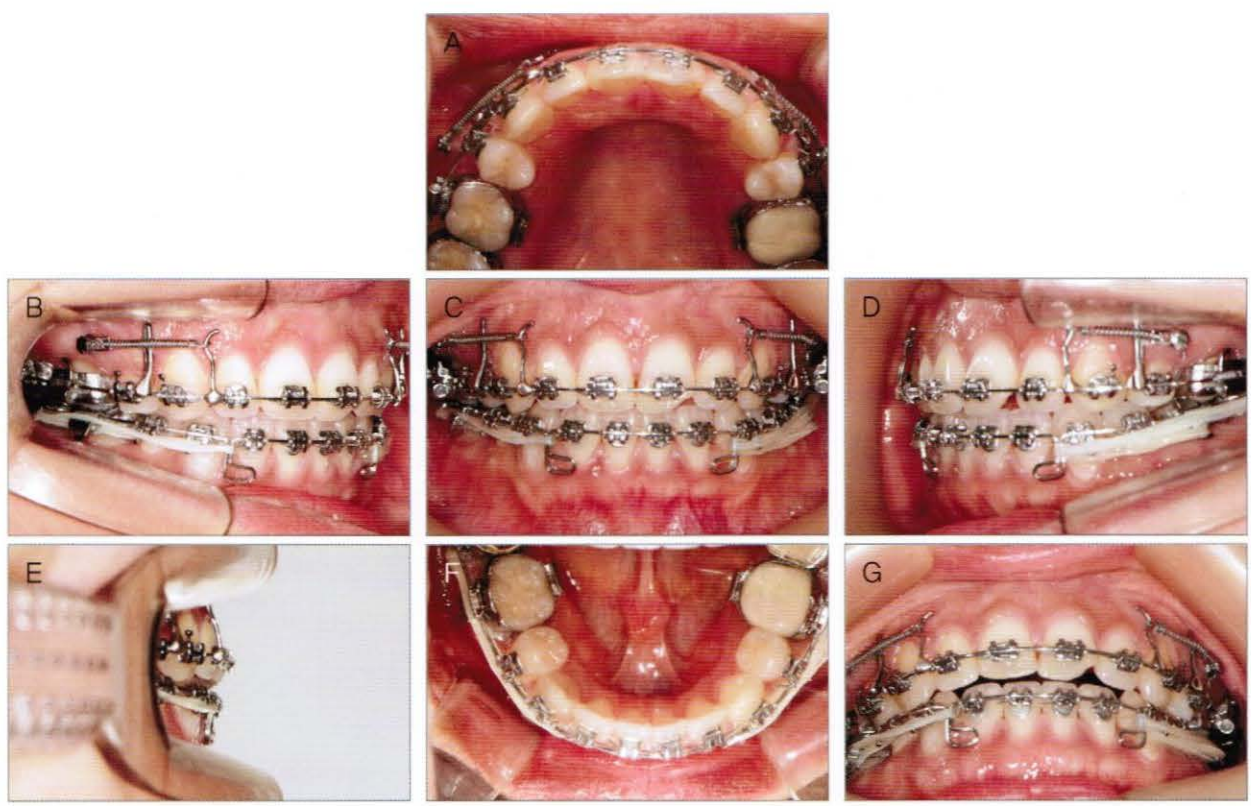


Figure 5-3-15. Completion of space closure (2005. 4.12)
Upper mini-implants have been removed.

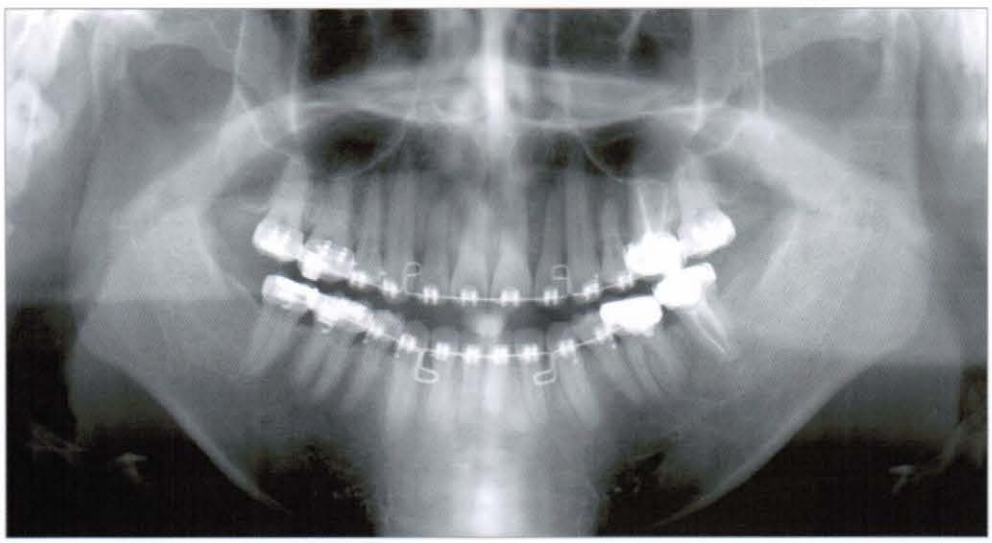


Figure 5-3-16. Panoramic radiograph at completion of space closure (2005. 4.19)
Root resorption of the upper incisors has occurred.

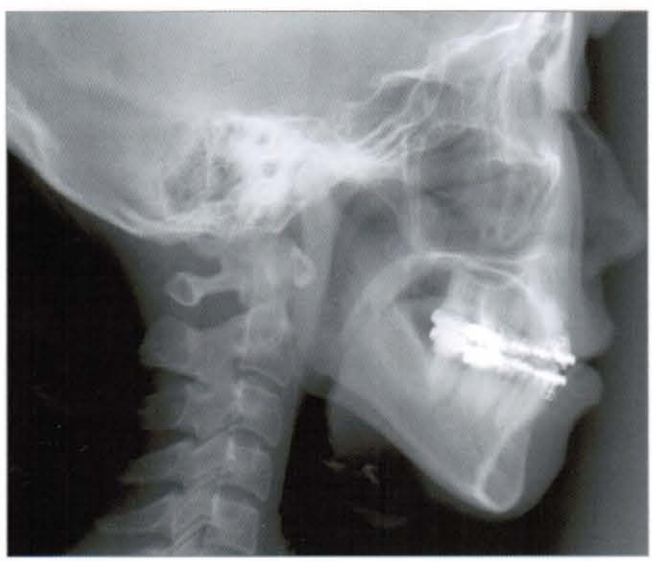


Figure 5-3-17. Cephalometric radiograph after space closure (2005. 4.19)

Clinical tip ››››

Always take panoramic and lateral cephalometric radiographs after incisor retraction.

When incisors are retracted using mini-implants, the amount of retraction is greater than with any other method since anchorage is reinforced. Therefore much root torque must be placed in the upper incisors, which increases the chances of root resorption.

Root resorption must always be checked at the last stage or on completion of incisor retraction.

Lateral cephalometric radiograph is used to check for root resorption (occurs often on the labial surface of the root tip) and incisor inclination (U_1 to FH), and also plans for the detailing stage made.

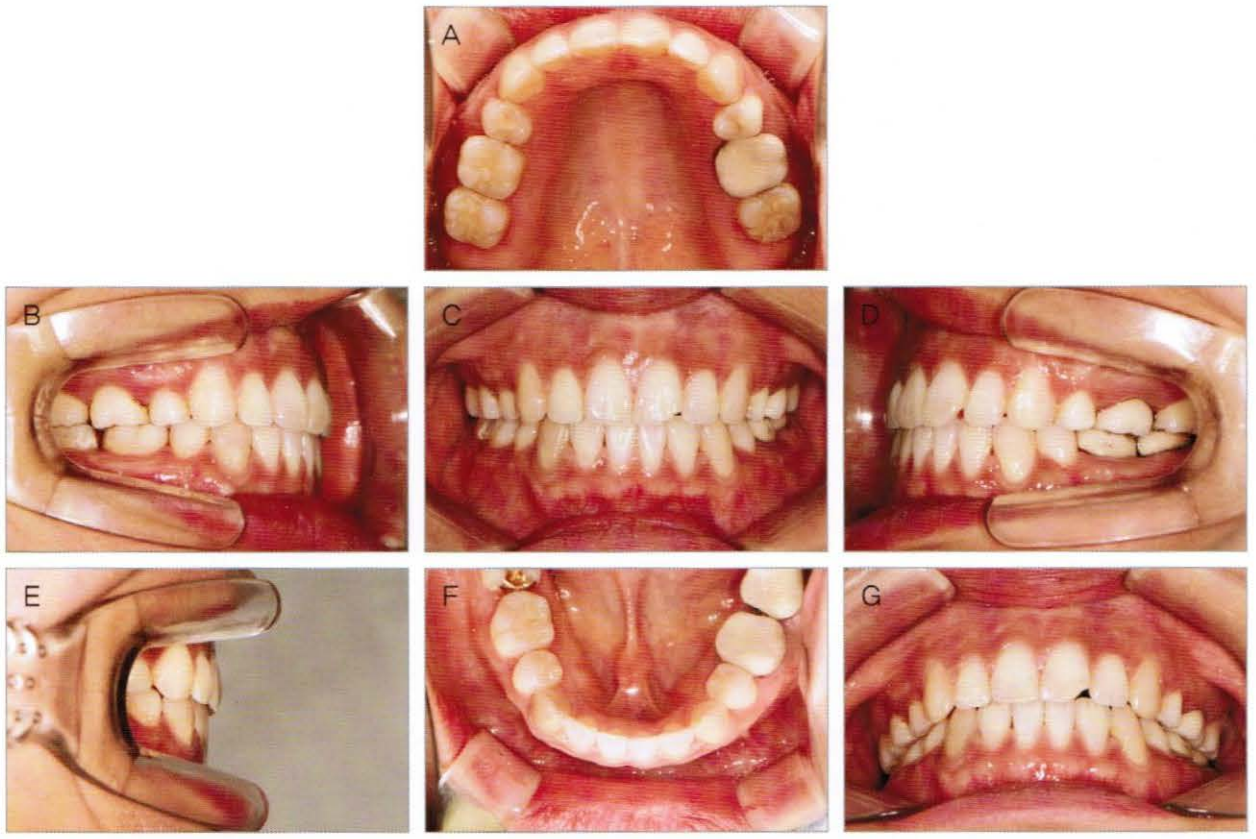


Figure 5-3-18. Intraoral photograph at debonding (2006. 1.3)
Class I molar and canine relationships have been obtained. Anterior open bite has been treated.

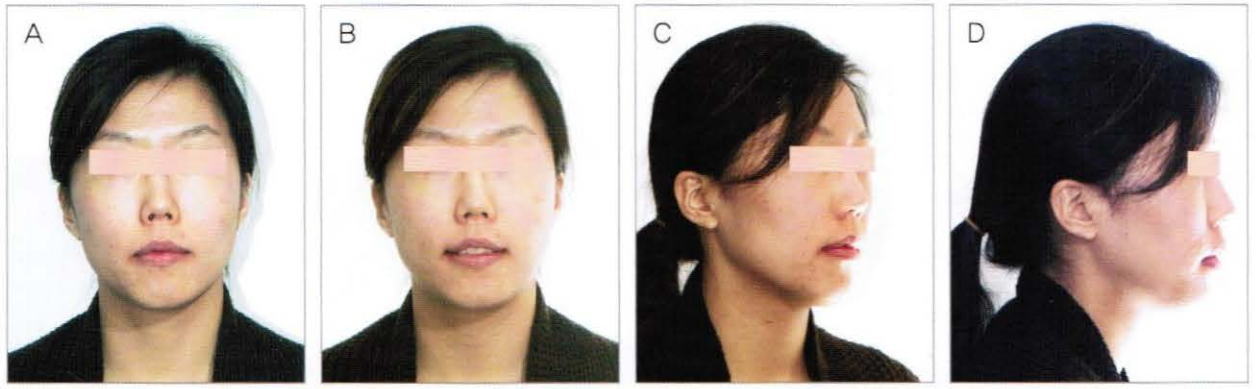
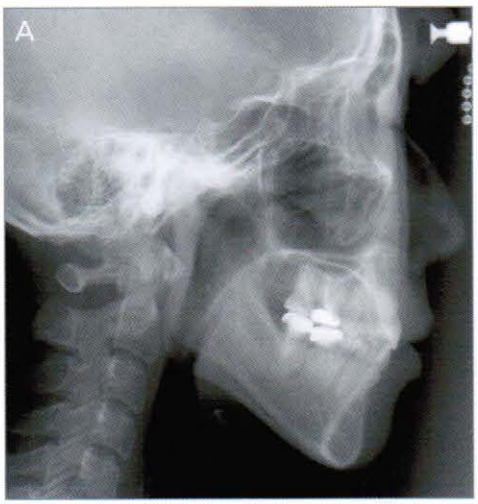
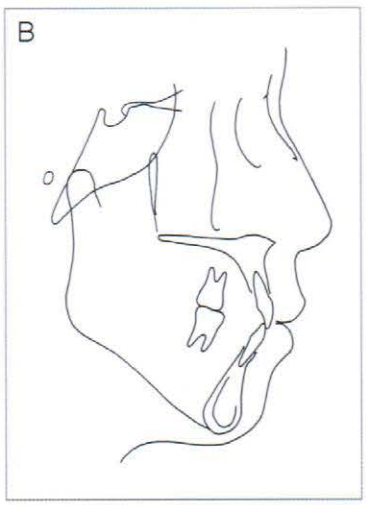
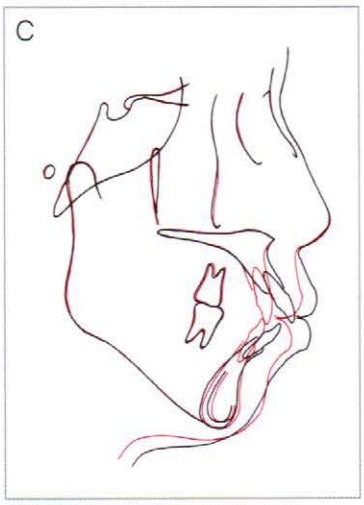
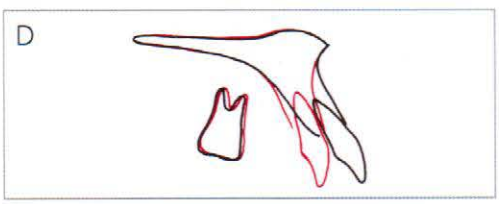


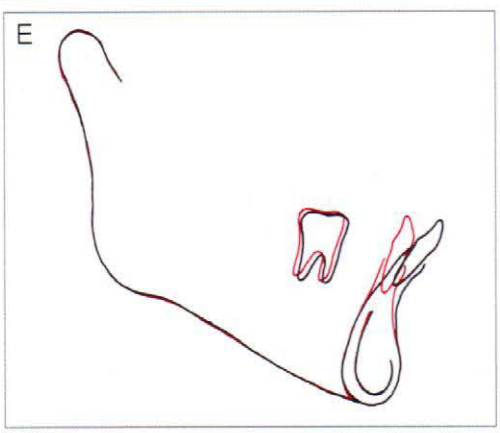
Figure 5-3-19. Facial photographs at debonding (2006. 1.3)
After debonding, lip protrusion has been relieved, and gummy smile improved. With relief of mouth protrusion, chin point looks as though advancement genioplasty has been performed. The nose also looks higher.











F

	Norm	SD	T1	T2	T3
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SNB	79.2	3.0	75.8	76.9	75.8
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FMA	24.3	4.6	37.4	35.9	37.0
U1 to FH	116.0	5.8	117.2	117.2	101.2
IMPA	95.9	6.4	98.0	96.5	87.2
IIA	123.8	8.3	107.4	108.6	134.7
Esth-U	-0.9	2.2	7.3	7.8	-0.2
Esth-L	0.6	2.3	9.4	10.9	1.9

Figure 5-3-20. Cephalometric radiograph at debonding (2006. 1.3)

A. Post-treatment cephalometric radiograph

B. Post-treatment cephalometric tracing

C. Pre- and post-treatment superimposition
Profile has improved. A fair amount of upper incisor retraction has occurred. The alveolar bone around the roots has been remodeled. Pogonion point has moved anteriorly. But anti-clockwise rotation of the mandible has not occurred. Black line indicates pre-treatment, and red line post-treatment.

D. The upper incisors have been retracted with the axis well maintained. The upper molars have been intruded.

E. The lower molars have been extruded.

F. Measurement.
T1 : pre-treatment, T2 : 4 months after upper molar intrusion, T3 : post-treatment
FMA has decreased slightly. ANB has decreased from 4.1° to 3.1°. Lip protrusion has decreased.

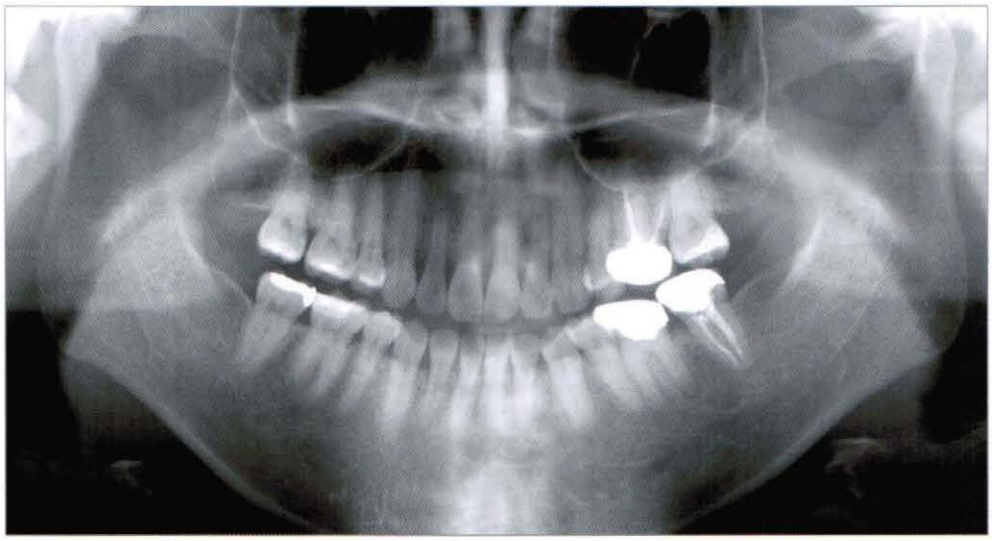


Figure 5-3-21. Panoramic radiograph at debonding (2006. 1.3)
There has been some root resorption.

Anticlockwise rotation of the mandible was expected with treatment in Case 7, but in reality not much change was observed. However if the mandibular angle is maintained without increase in Class II open bite cases, it can be seen as being successful. Using traditional methods, Class II elastics and up-and-down elastics are used, which increases the mandibular plane angle and lower facial height. For further explanation, Case 7 and a case with a similar skeletal pattern will be compared. This case was treated using traditional methods.

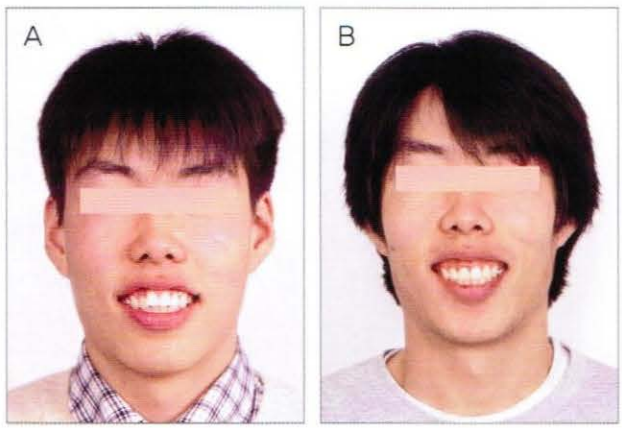


Figure 5-3-22. Smiling facial photograph of skeletal Class II open bite patient treated with traditional methods
A. Pre-treatment
B. Post-treatment. Gummy smile has worsened after treatment.

Figure 5-3-23. Pre-treatment intraoral photograph
He shows a Class II canine and molar relationship. There is open bite and reverse curve in the upper arch similar to Case 7.

Figure 5-3-24. Intraoral photograph during treatment
The upper first premolar and lower second premolar were extracted. TPA was used for anchorage reinforcement and to prevent side-effects which may occur with high-pull headgear treatment. The upper canines were retracted, then the four incisors, in two steps.

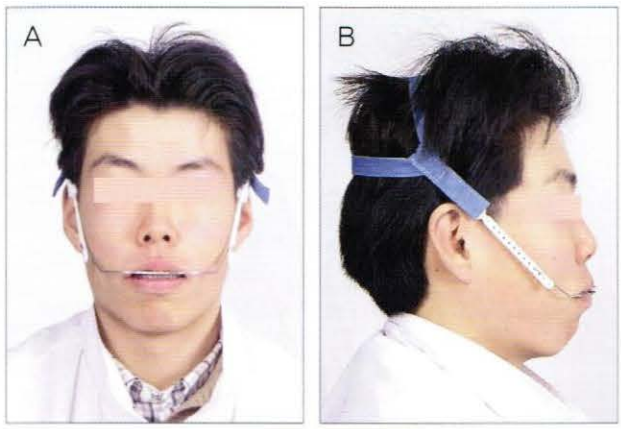


Figure 5-3-25. High-pull headgear is used to stop mesial movement and extrusion of the upper first molars. Because patient compliance was low, great treatment effects were not achieved.

Figure 5-3-26. Post-treatment intraoral photograph
Class I canine and molar relationship was achieved, with good overbite and overjet.

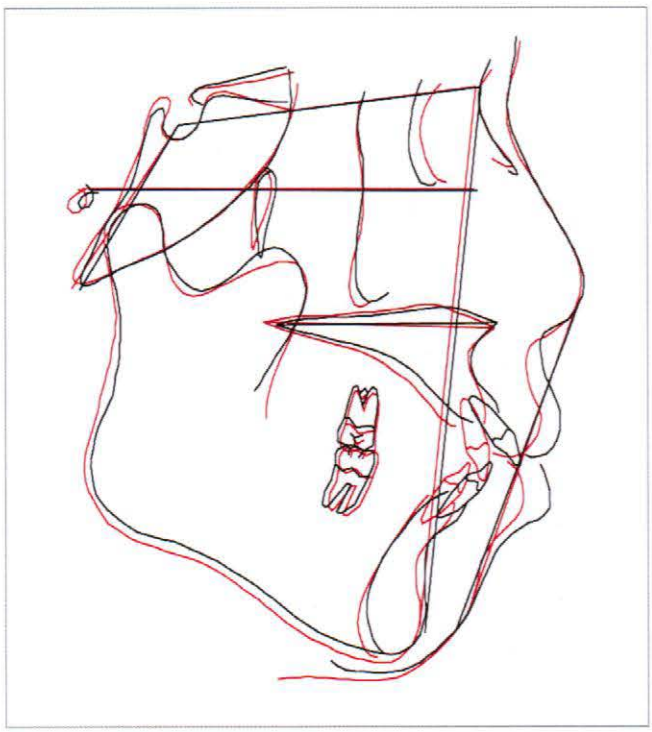


Figure 5-3-27. Superimposition of pre-treatment and post-treatment tracing
Compare with Figure 5-3-20C of Case 7. The mandible has rotated clockwise, and the lower facial height has increased. With backward movement of Pogonion, the tip of the chin looks retruded. With extrusion of the upper incisors, gingival display on smiling has become worse (refer to Figure 5-3-22).

Clinical tip ››››

Minimize the use of Class II and up-and-down elastics in Class II open bite cases.

Class II elastics cause extrusion of upper and lower incisors, and clockwise rotation of the mandibular plane. This will in turn cause increase in the lower facial height, worsening of lip protrusion, retrusion of the chin, and increase in gummy smile.

Mini-implants are the best option for minimizing the use of Class II and up-and-down elastics.

■ Case 8 (Figure 5-4-1 to 17)

- Age : 22 years and 7 months
- Sex : female
- Chief complaint : open bite, mouth protrusion

Treatment for this case has not finished, but it is introduced as it uses mechanics most preferred by the author (Method 5).

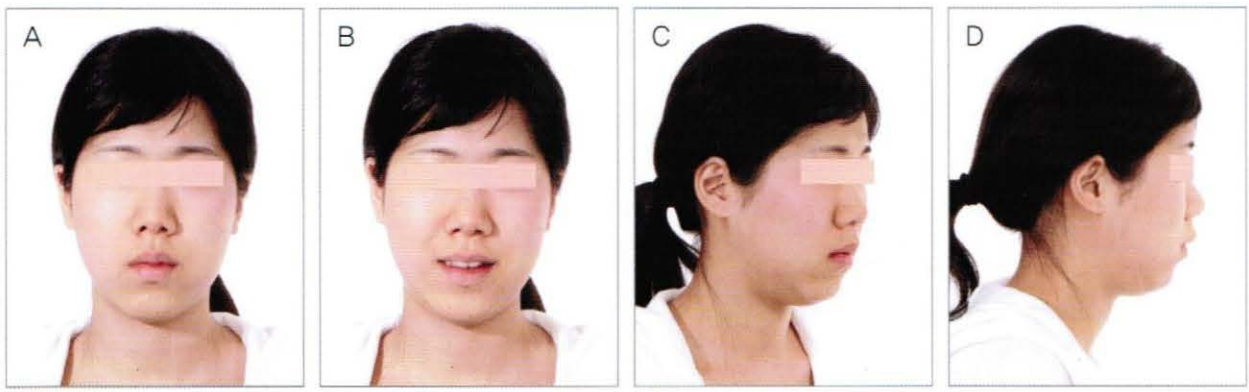


Figure 5-4-1. Pre-treatment facial photograph of Case 8
She shows mouth protrusion. Exposure of the incisors during smile is sufficient. There is slight muscle tension and double chin on mouth closure.

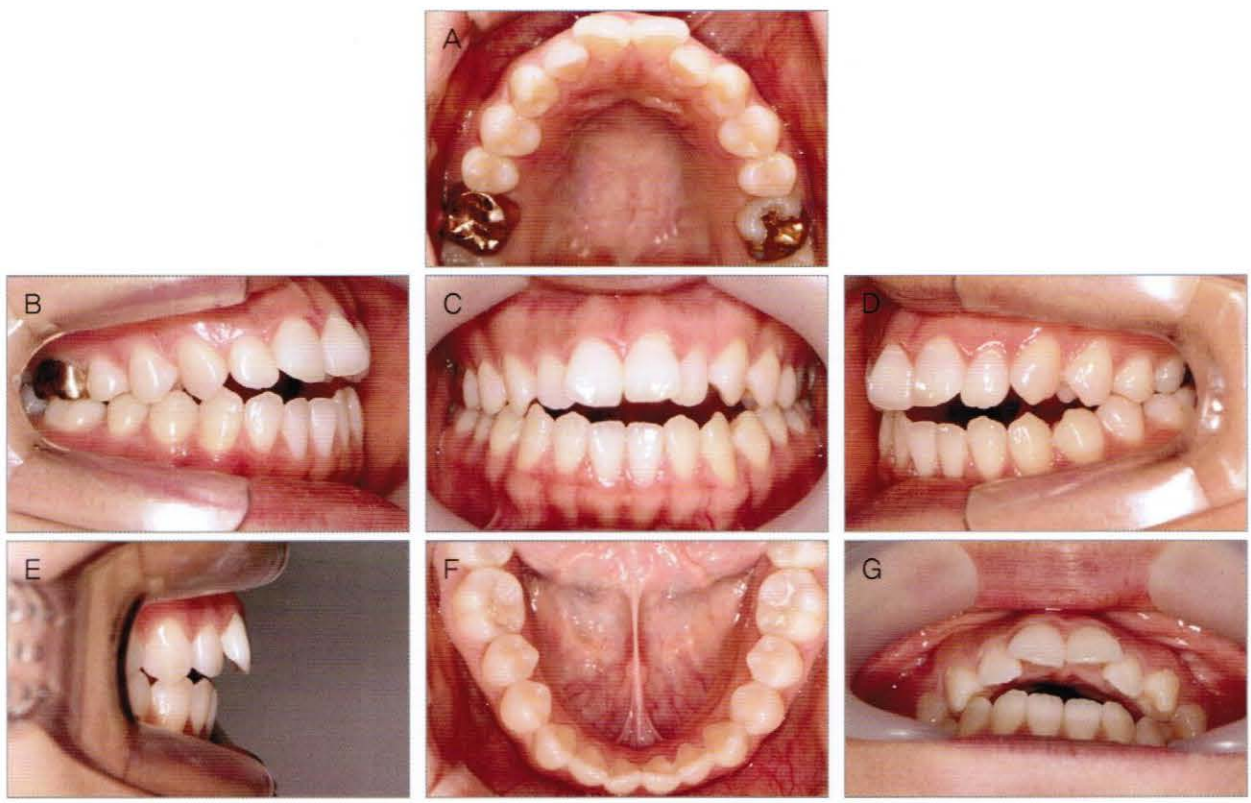
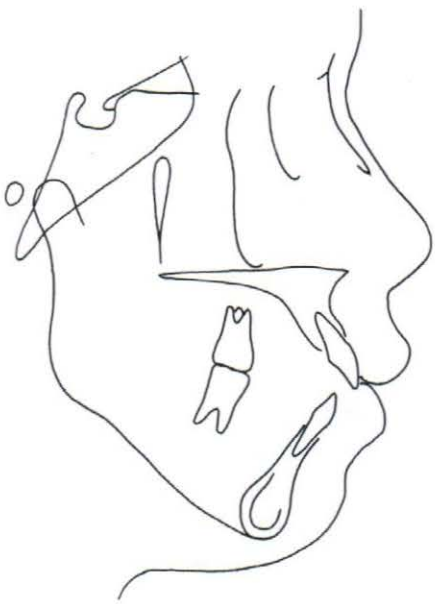


Figure 5-4-2. Pre-treatment intraoral photographs of Case 8
Both sides show Class I molar relationships, but with a slight Class II tendency. There is open bite. Both upper and lower occlusal planes have mild reverse curves.

B



C

	Norm	SD	T1
SNA	81.6	3.2	79.7
SNB	79.2	3.0	74.7
ANB	2.5	1.8	5.0
FMA	24.3	4.6	39.4
ODI	72.2	5.5	62.9
U1 to FH	116.0	5.8	116.5
IMPA	95.9	6.4	84.5
IIA	123.8	8.3	119.5
Esth-U	-0.9	2.2	5.9
Esth-L	0.6	2.3	2.9

Figure 5-4-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. The radiograph shows distinctive characteristics of skeletal Class II open bite. Comparing the level of the vermillion border and the upper incisal edge, slight extrusion of the upper incisors can be allowed.
C. ANB of 5.0° and FMA of 39.4° are larger than normal.

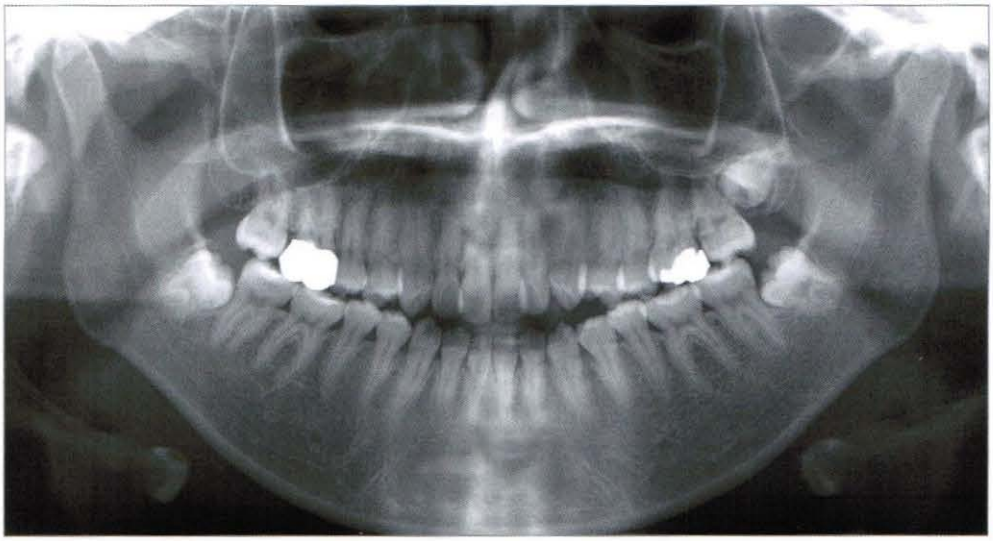


Figure 5-4-4. Pre-treatment panoramic radiograph
Condyle head shows normal anatomy. The third molars are impacted.

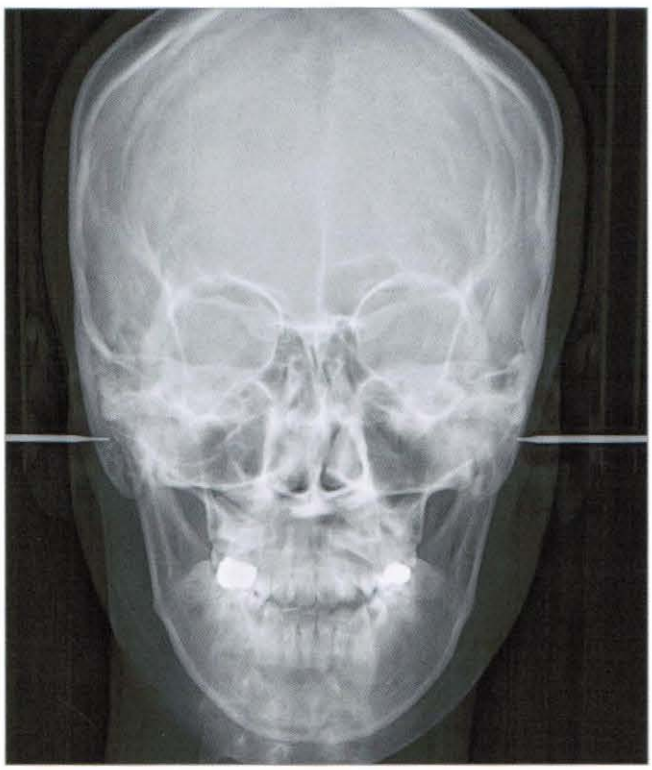


Figure 5-4-5. Pre-treatment postero-anterior radiograph. It shows no abnormalities.

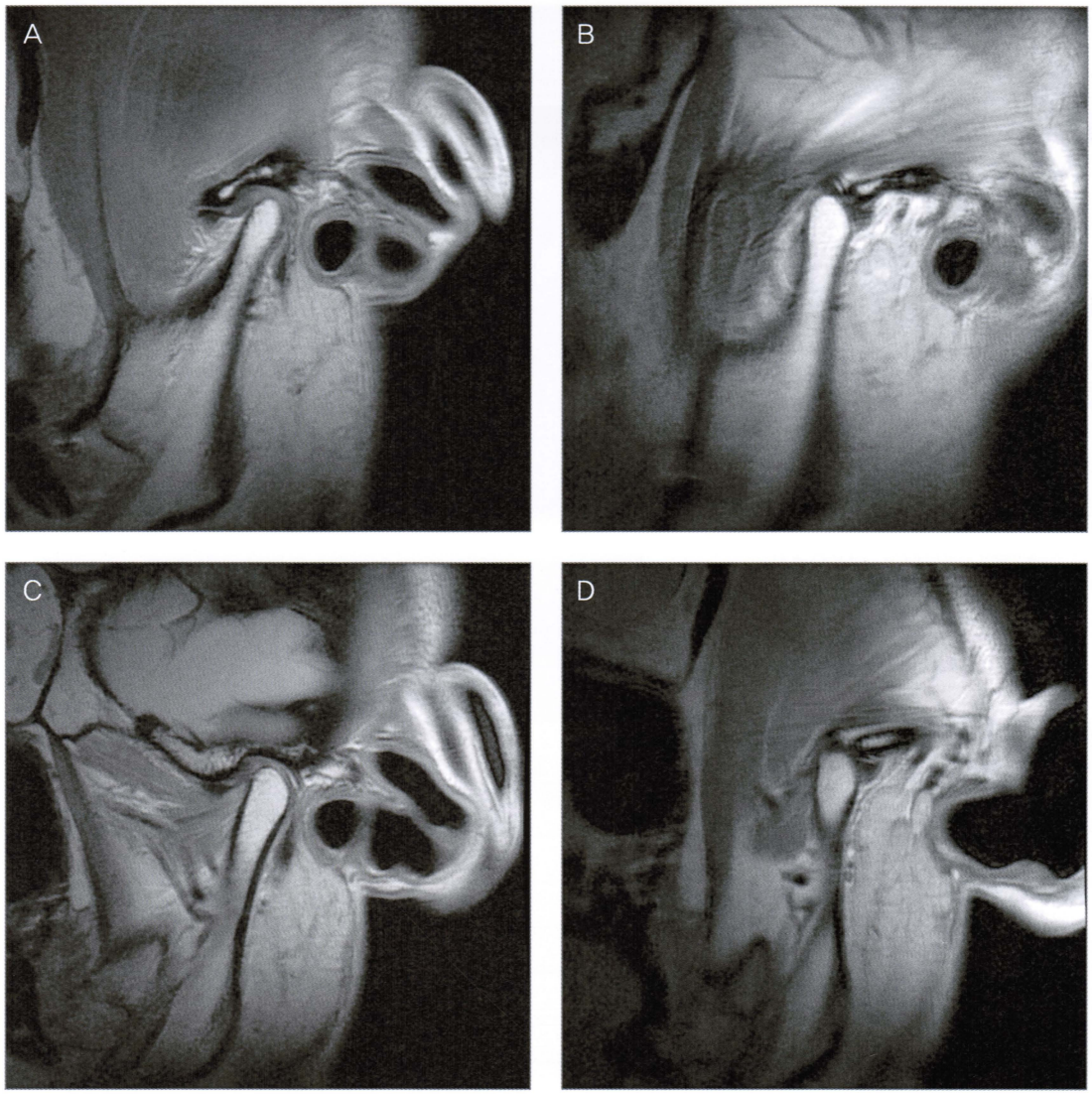


Figure 5-4-6. Pre-treatment MRI of the TMJ
Both sides of the TMJ show ADD with reduction.
A. Right closed view, B. right maximal opening view, C. left closed view, D. left maximal opening view

Treatment Progress

- **Leveling** — 5 months
  - 2007. 4.3 — 014″ NiTi
  - 2007. 5.8 — 016″ NiTi
  - 2007. 6.5 — 016×022″ NiTi
  - 2007. 7.3 — 018×022″ ss with shoe hooks
- **Implantation & Intrusion of molars**
  - 2007. 8.10 — 1.6×6mm mid-palatal + TPA
  - 2007. 9.10 — Start of intrusion
    U : 019×025″ ss with shoe hooks
- **Anterior retraction & Intrusion of molars**
  - 2007. 9.10 ~ Present — 5/16″ 6oz Class I elastics

Because the open bite was severe, it was explained to the patient prior to treatment that orthognathic surgery was a possiblility. To treat the Class II relationship, upper first premolar and lower second premolar were extracted. All third molars were also extracted.

Even though this case had reverse curves in both arches, the upper and lower molars were not intruded using segmental wires. The reason for this is that she only showed lip strain on mouth closure, and the level of the vermillion border and upper incisal edge showed that some extrusion of the incisors can be allowed. Therefore it was decided to use continuous wires for leveling to allow slight extrusion of upper and lower incisors and the rest of the open bite treated through molar intrusion.

Because the upper and lower incisor axes were close to normal, 019x015″ shoe hooks were given crown labial torque of 5~10° while retracting the upper incisors. During molar intrusion, crown labial torque of 15° was given to the molar to prevent only the first molars from becoming inclined palatally, and allow molars to be intruded together (Figure 5-4-17).

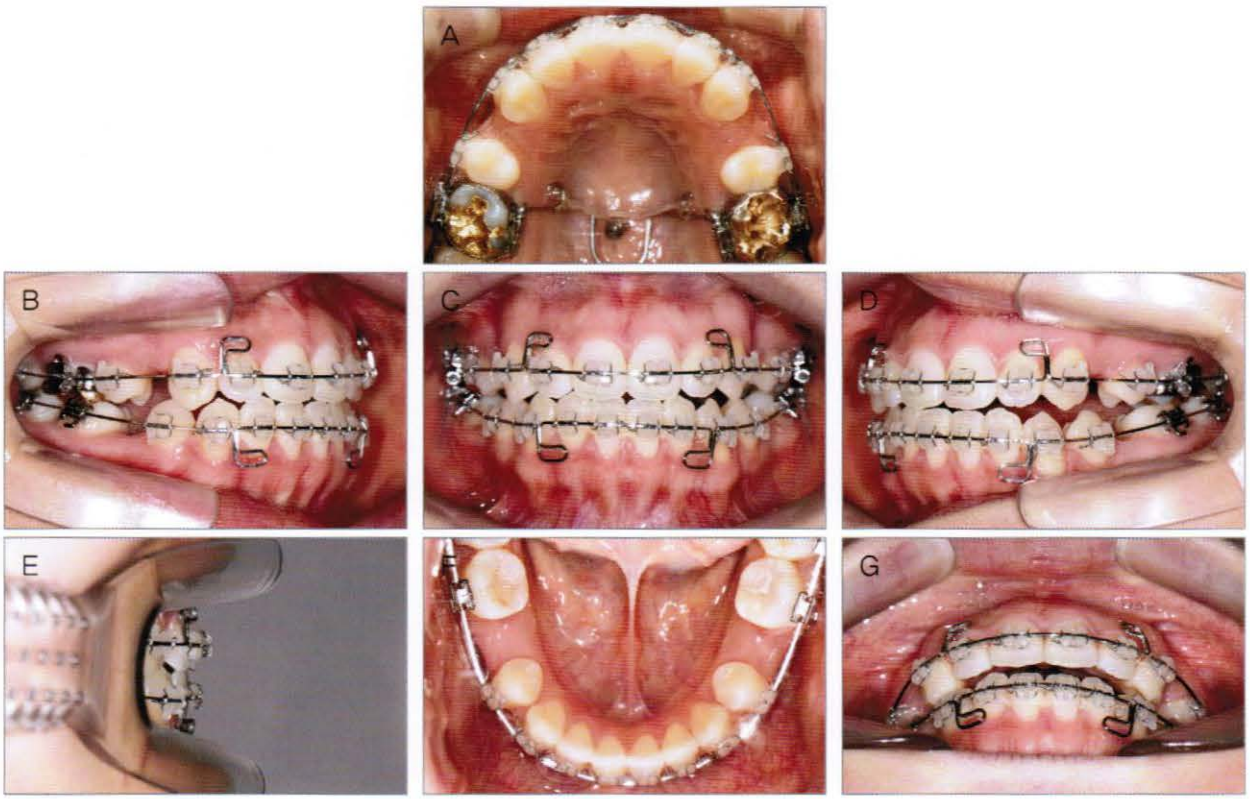


Figure 5-4-7. Intraoral photographs after 5 months of leveling (2007. 9.10)
Overbite has increased during leveling with continuous archwires (C). Overjet has also decreased (E, G).
Upper molar intrusion was begun using TPA. Power chain connected from the hook of the TPA and mini-implant can be seen. Detailed description of the mechanism are shown in Figure 5-4-17 and Chapter 5, section A, Method 5.

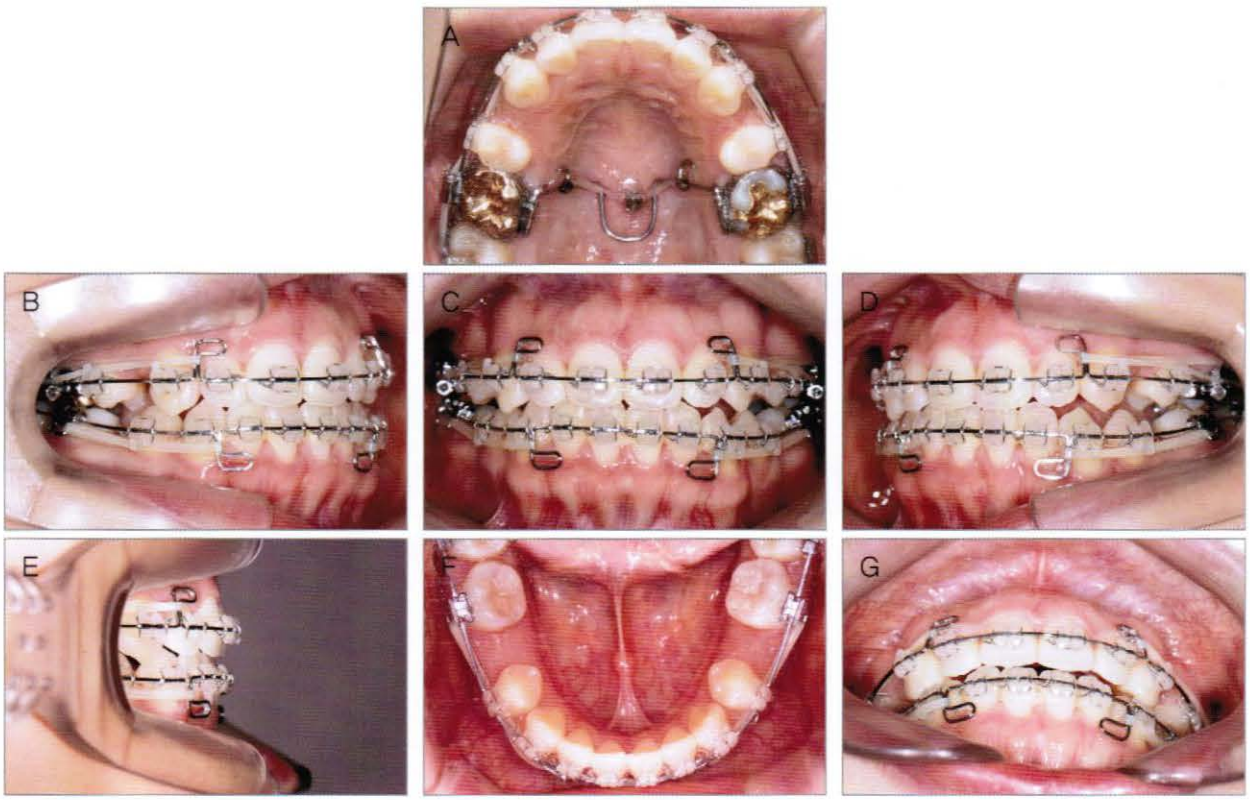


Figure 5-4-8. Intraoral photograph at incisor retraction stage, 40 days after upper molar intrusion (2007. 10.22)
Power chain and elastics (5/16″ 6 oz) are used for incisor retraction, with continued molar intrusion by using power chain from the TPA hook to the mini-implant. Overbite has increased and overjet has decreased.

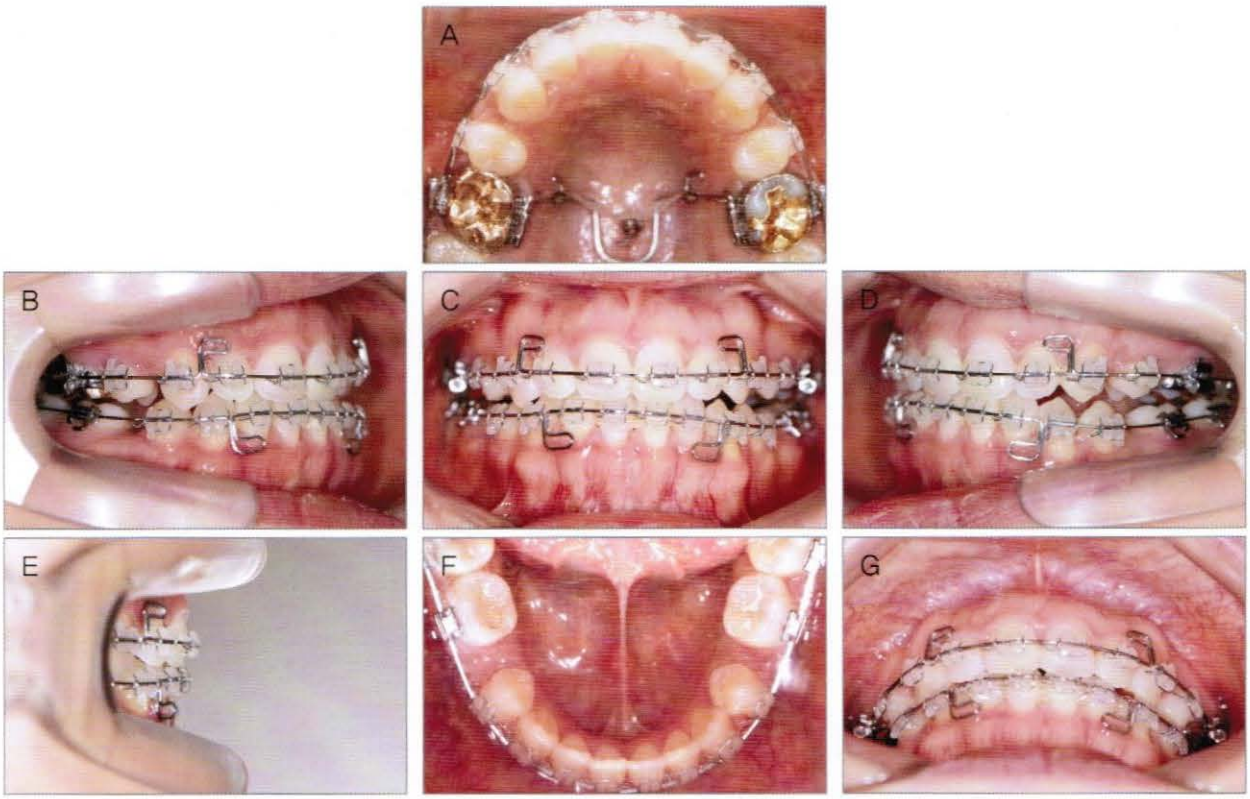


Figure 5-4-9. Intraoral photographs at the incisor retraction stage, 5 months after molar intrusion (2008. 2.18)
Power chain and elastics (5/16″ 6 oz) are used for incisor retraction, with continued molar intrusion through power chain from the TPA hook to the mini-implant. There has been further increase in overbite and decrease in overjet.

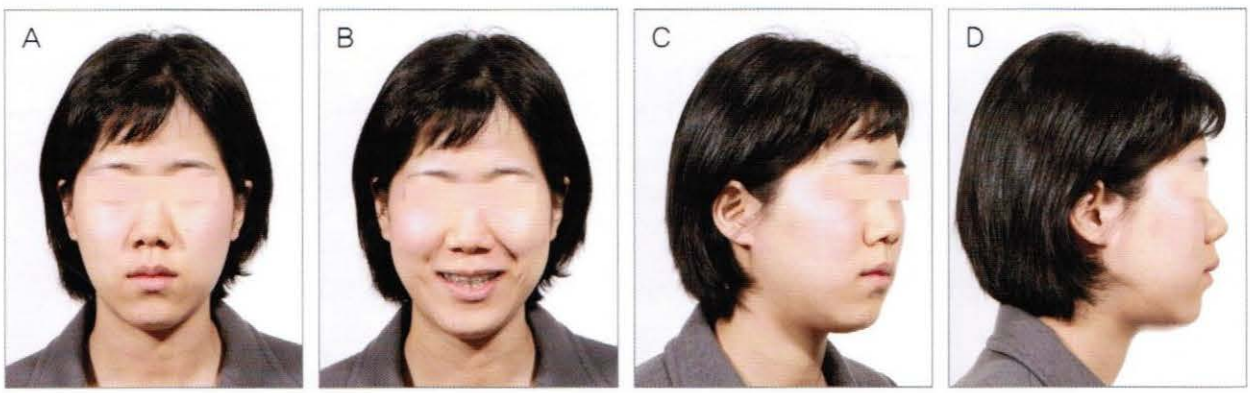
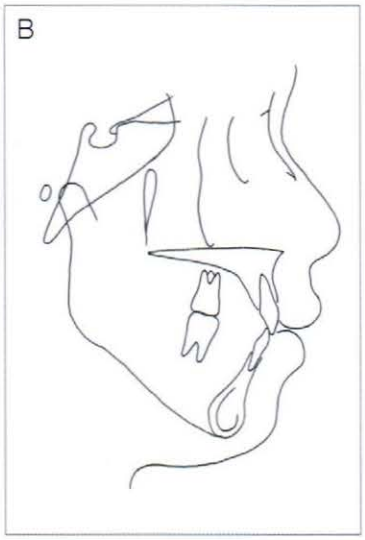
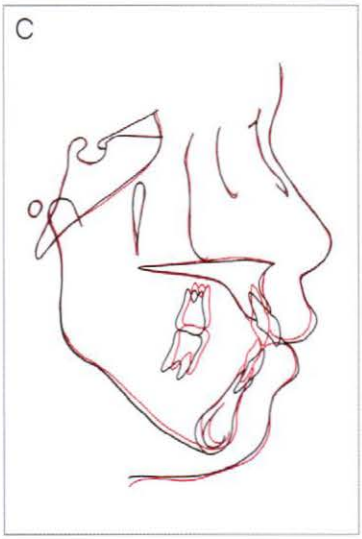
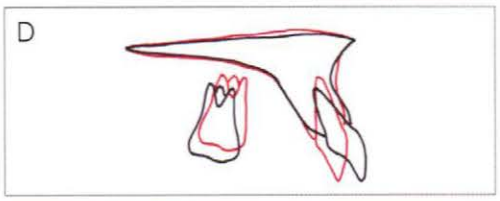
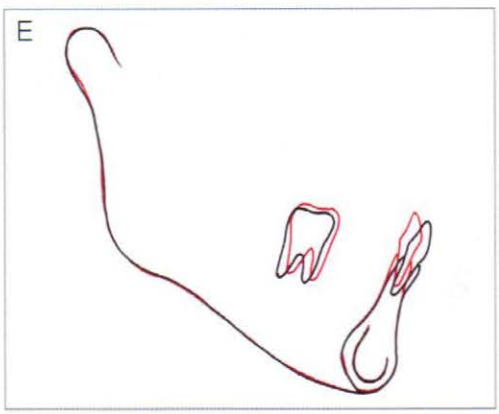


Figure 5-4-10. Facial photographs at incisor retraction stage (2008. 2.18)
Mouth closing has become easier. This is from a decrease in lower facial height due to incisor retraction and upper molar intrusion. With further treatment, it is expected that mouth protrusion will be further relieved.









F

	Norm	SD	T1	T2
SNA	81.6	3.2	79.7	81.0
SNB	79.2	3.0	74.7	75.7
ANB	2.5	1.8	5.0	5.3
FMA	24.3	4.6	39.4	38.3
ODI	72.2	5.5	62.9	63.6
U1 to FH	116.0	5.8	116.5	97.9
IMPA	95.9	6.4	84.5	75.9
IIA	123.8	8.3	119.5	148.0
Esth-U	-0.9	2.2	5.9	2.4
Esth-L	0.6	2.3	2.9	0.5

Figure 5-4-11. Cephalometric radiograph and measurement at the incisor retraction stage, 5 months after upper molar intrusion (2008. 2.18)
A. The mini-implant can be seen at the mid-palatal area. Decrease in overbite and overjet has occurred.
B. Tracing
C. Superimposition of tracing. Superimposition was carried out from S point, N point and also from the mini-implant. The mandible has been autorotated anti-clockwise due to intrusion of upper molars. Black line is pre-treatment, and red line is post-treatment.
D. Not only upper first molars but also upper incisors have been intruded.
E. Lower first molars have been extruded slightly.
F. FMA has decreased from 39.4° to 38.3°.

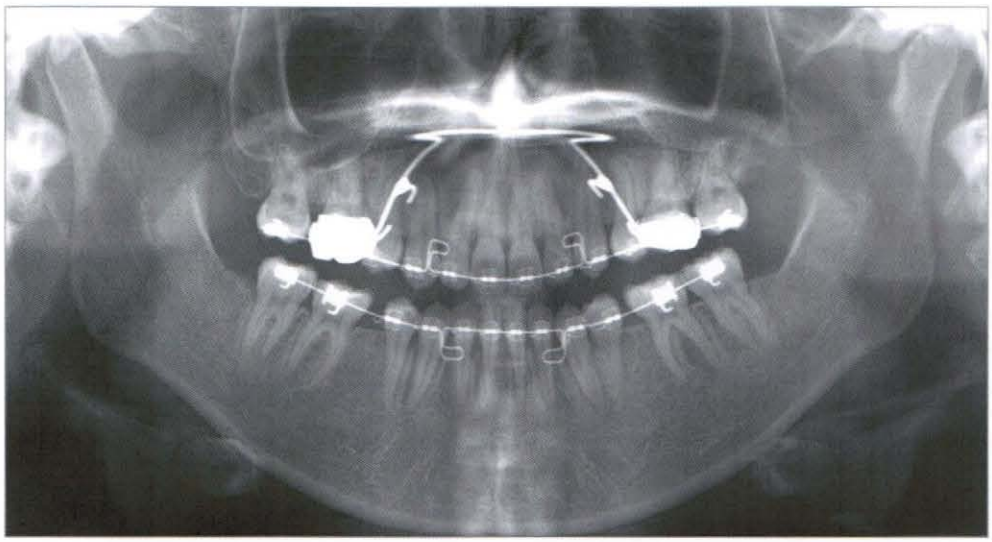
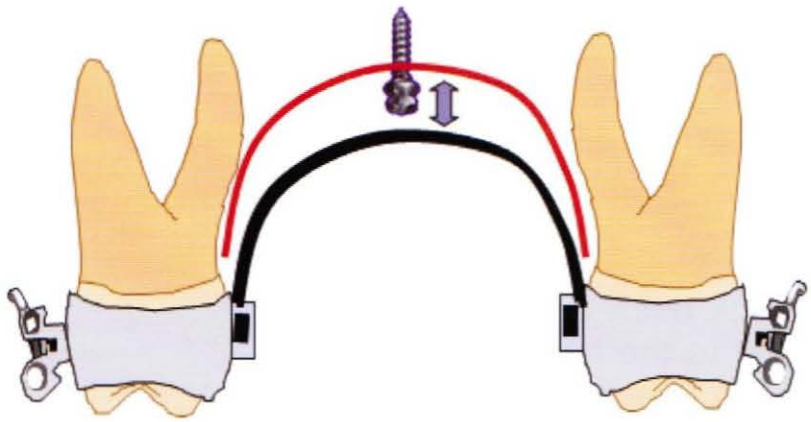


Figure 5-4-12. Panoramic radiograph taken at the incisor retraction stage, 5 months after upper molar intrusion (2008. 2.18) No abnormalities such as root resorption are seen.

<Clinical points of upper molar intrusion using Method 5>

1) Clinical point I

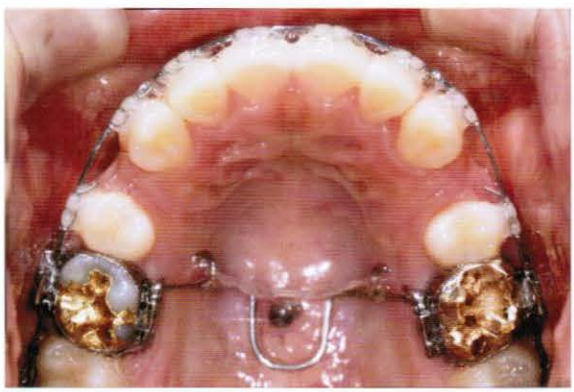


• There should be some space between the TPA and palatal tissue, which prevents the palatal bar fron impinging the palatal tissue as the molars are being intruded.

Figure 5-4-13. With continued intrusion of molars through power chain to the TPA hooks, the bar of the TPA will impinge on the palatal soft tissues. The TPA should be placed away from the palate the same distance the molars are planned to be intruded.

2) Clinical point Ⅱ - How to ligate the power chain

Clinical tip for a mid-palatal mini-implant

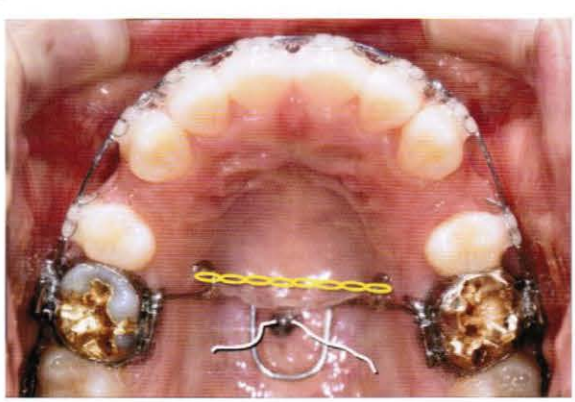


A

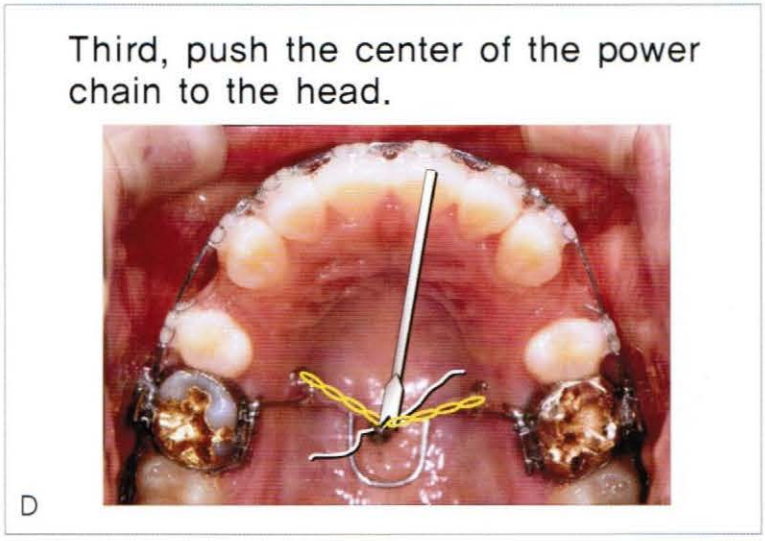
First, insert the steel ligature into the hole or ligate it around the neck.

B

Second, hook each ends of the power chain to the hooks of TPA



C



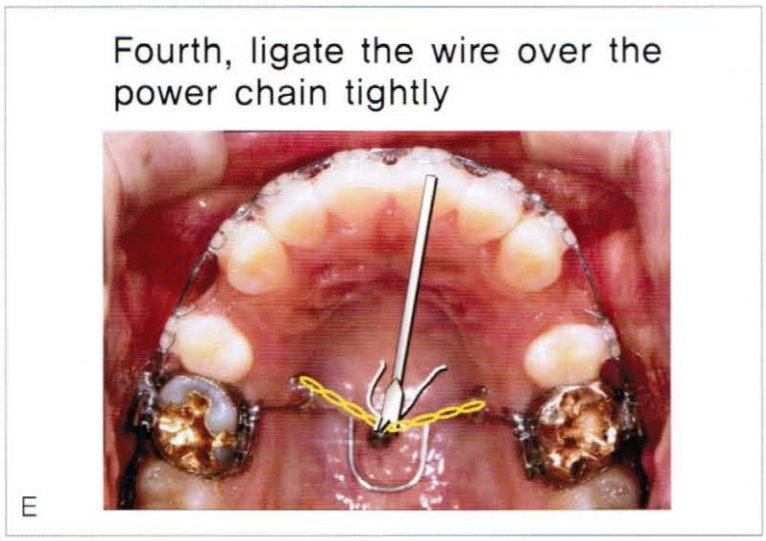


Figure 5-4-14. Intrusive force applied through power chain from the hook of the TPA to the mini-implant head
A. Power chain has been ligated from the mini-implant head to the TPA hook.
Actual ligation of power chain onto the hook is not an easy process. By following the instructions given in Figures B~E, easier ligation of power chain can be achieved.
B. First, insert the steel ligature into the hole in the head of the mini-implant, or ligate it around the neck.
C. Hook each ends of the power chain onto the hooks of the TPA.
D. Push the center of the power chain to the head of the mini-implant using a tucker.
E. Ligate the ligature wire over the power chain tightly. Leaving around 3mm, this free end is inserted under the head to prevent trauma to the tongue.

3) Clinical point Ⅲ

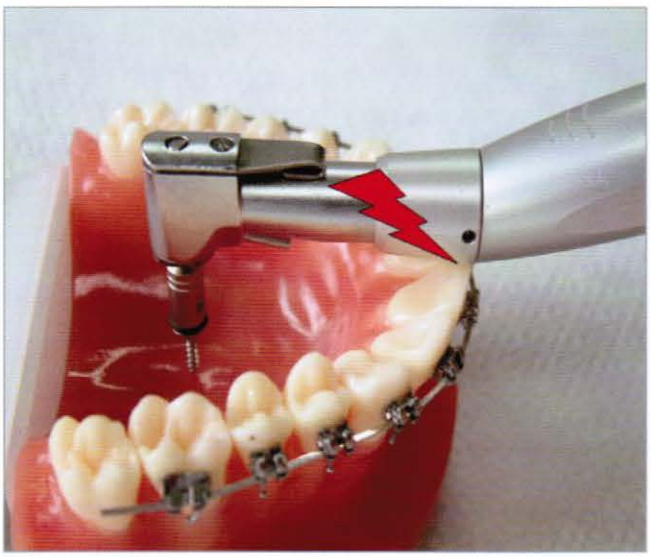


Figure 5-4-15. When inserting a mini-implant in the mid-palate, use a long bur-type wrench. At least 6mm of space must be left between the handpiece and lower incisal edge before beginning insertion. If this is not done, the handpiece will hit the lower incisal edge during insertion and prevent full implantation.

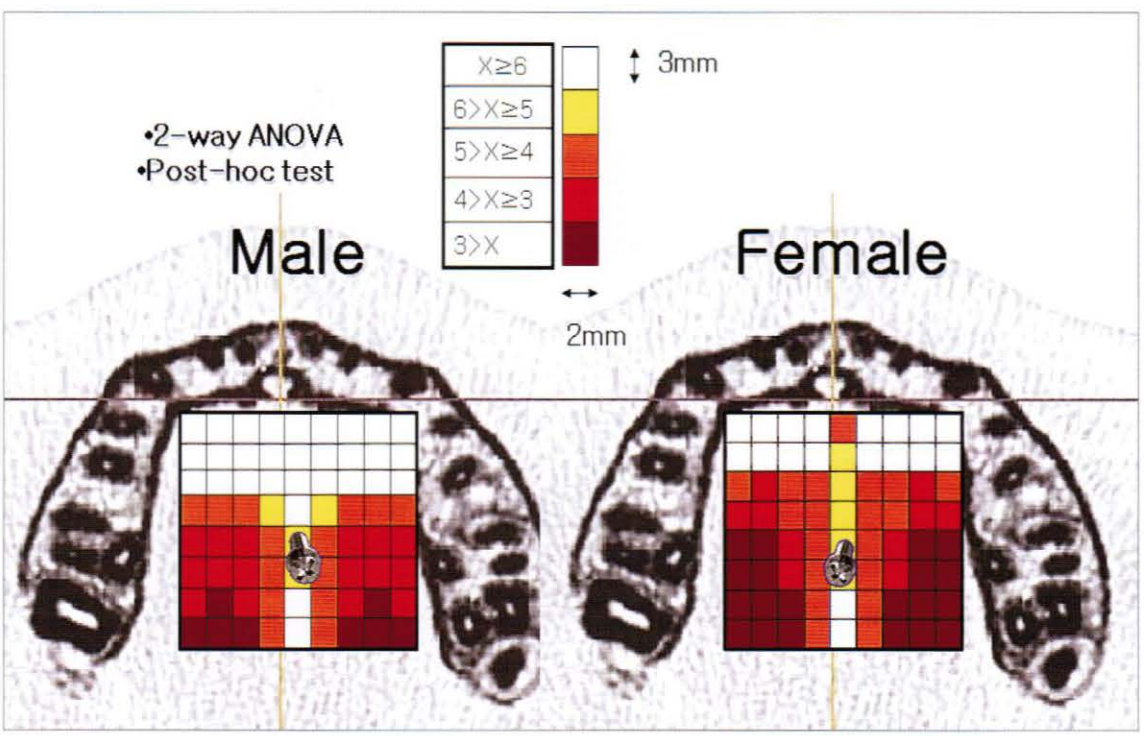
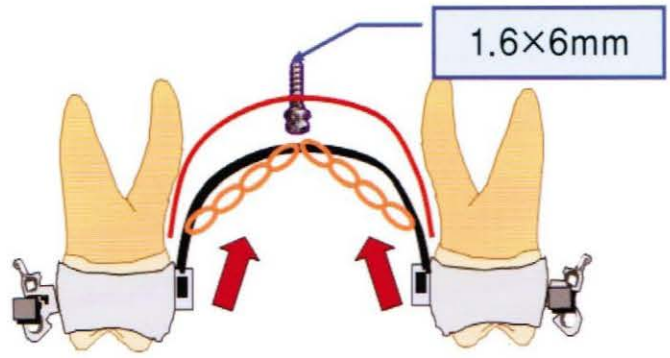


Figure 5-4-16. Using CT, bone thickness in the mid-palate and surrounding areas was measured in the direction of mini-implant insertion. The yellow and white areas indicate safe bone thickness. Use mini-implants of less than 6mm length, and do not deviate more than 2mm away from the mid-palate.

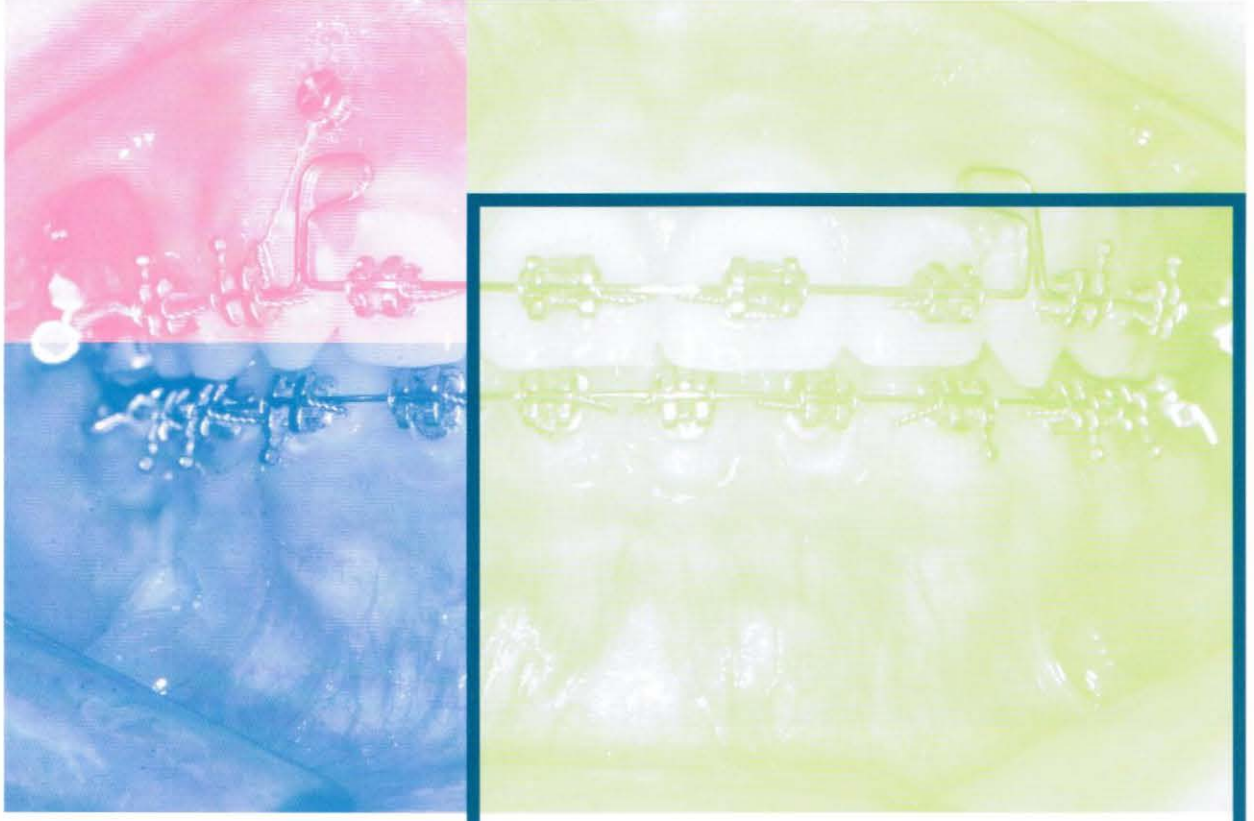
「Reference : Sungmin Kang, Shin-Jae Lee, Sug-Joon Ahn, Min-Suk Heo, Tae-Woo Kim. Bone Thickness of the Palate for Orthodontic Mini-implant Anchorage, Am J Orthod Dentofacial Orthop 2007:131(4)-Supplement 1:74-81.」

Method 5



This is a method using a TPA with crown buccal torque and a midpalatal mini-implant to intrude molars.

Figure 5-4-17. The direction of intrusion causes the molars to be tipped palatally, and the upper arch to be constricted. To prevent this, TPA should be slightly expanded and crown buccal torque placed in the first molars. Buccally, 019×025″ ss or thicker wire is used also with crown buccal torque of around 15°. This reduces the play between the bracket slot and wire, and allows the posterior teeth to be intruded together instead of only the first molars. The buccal wire is also expanded slightly.



Chapter 6

Incisor intrusion

Chapter 6 Incisor intrusion

I . Treatment of deep overbite

From 1995 to 1997, I had the chance to study the topic 'Long-term stability of orthodontic treatment' at the University of Washington in Washington State, USA. On investigation of the long term stability of Class II division 2 deep bite patients, it was found that deep bite showed a high relapse. Nearly all the patients in the ten year or more retention group showed that treatment was carried out using molar extrusion. Molar extrusion was the treatment mostly used for deep bite in the past. However with the introduction of Dr. Burstone's segmented arch technique, upper incisor intrusion became a possibility. But this method was very complicated and patient compliance was needed for high-pull headgear and other devices. Recently mini-implants have been used for treatment of Class II division 2 deep bite. It is a simple procedure which does not require patient compliance. Although there is yet no concrete evidence that treatment through incisor intrusion is more stable long term, we can now freely intrude anterior teeth and can be free from the limitations of the past when molar extrusion was the only treatment available (Figure 6-1-1).

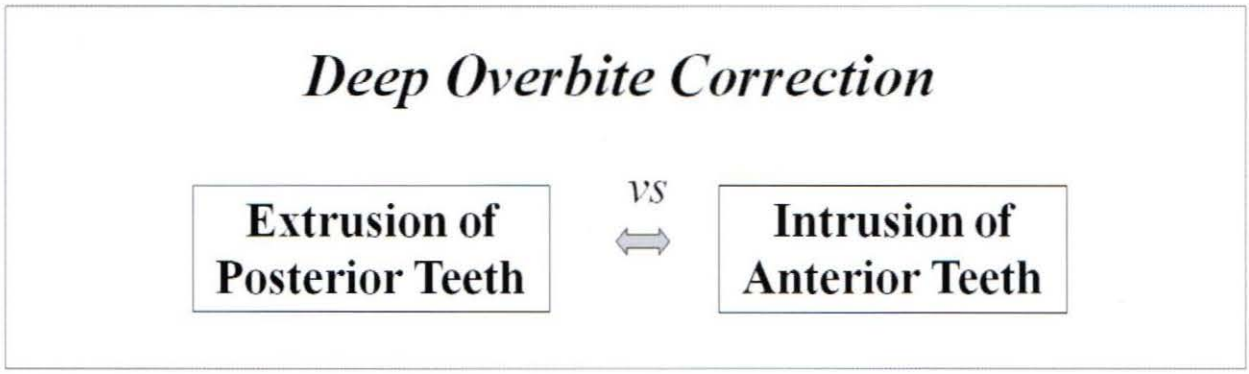


Figure 6-1-1. During diagnosis of deep bite, the most important point to consider is whether the molars will be extruded or the incisors intruded.

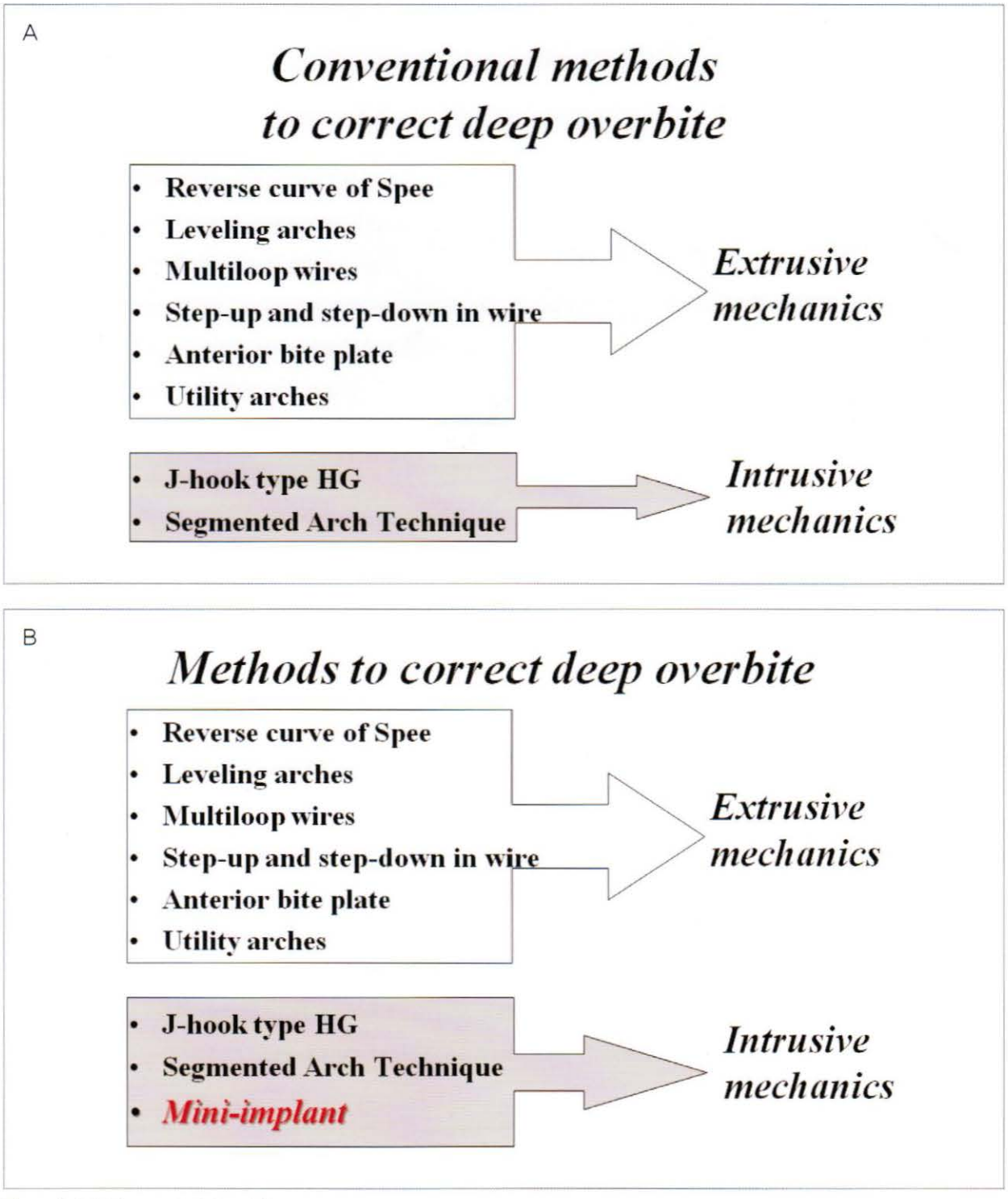


Figure 6-1-2. Treatment of deep bite

A. Conventional methods. For incisor intrusion, J hook or high-pull headgear needed to be used. These devices are all exposed to the outside and need absolute patient compliance.

B. Recent methods for treatment of deep bite. By adding mini-implants as mechanics for incisor intrusion, treatment has become much simpler with better results as there is no need to rely on patient compliance.

Indications

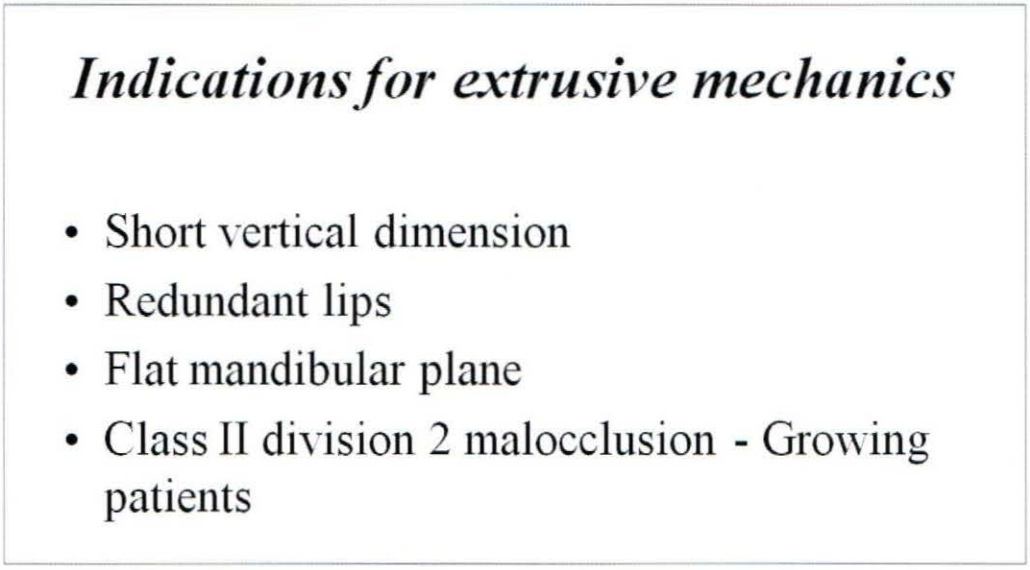


Figure 6-1-3. Indications for molar extrusion
Cases where molar extrusion can be applied include short vertical dimension, sufficient upper lip length, flat mandibular plane, and growing Class II division 2 malocclusion patients. Treatment of deep bite through molar extrusion in non-growing patients usually results in closure of the opened mandibular plane and relapse of deep bite.

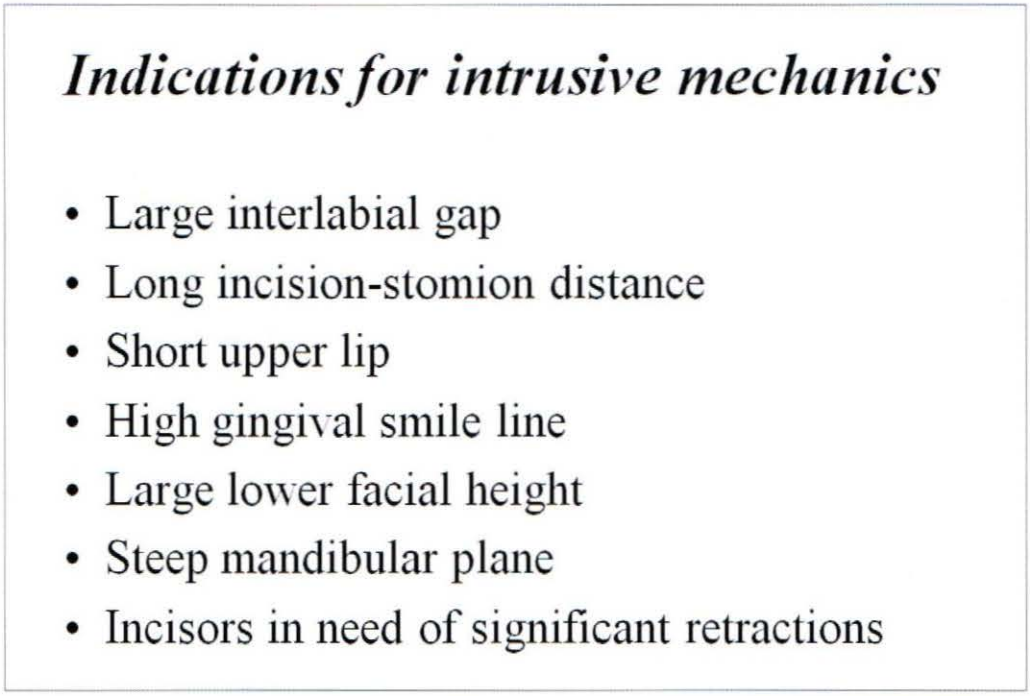


Figure 6-1-4. Indications for incisor intrusion

Patient characteristics where intrusion with mini-implants will provide good results (Figure 6-1-4)

- Lip incompetency at rest (Figure 6-1-5A) where the upper and lower lips are parted at rest.
- At rest, the upper incisal edge sits lower than the vermillion border of the upper lip, and the lower lip covers a large area of the descended upper lip (Figure 6-1-5A, Figure 6-1-7).
- Short upper lip
- There is severe incisor and gingival display during smile
- Large lower facial height. If the molars are extruded, lower facial height increases and is esthetically unfavorable.
- Large mandibular plane angle. The mandibular plane will become steeper if molars are extruded. This must be treated through incisor intrusion.
- When upper incisors are in need of significant retraction. After first premolar extraction and during incisor retraction, the upper incisors will be lingually tipped while causing deep bite.

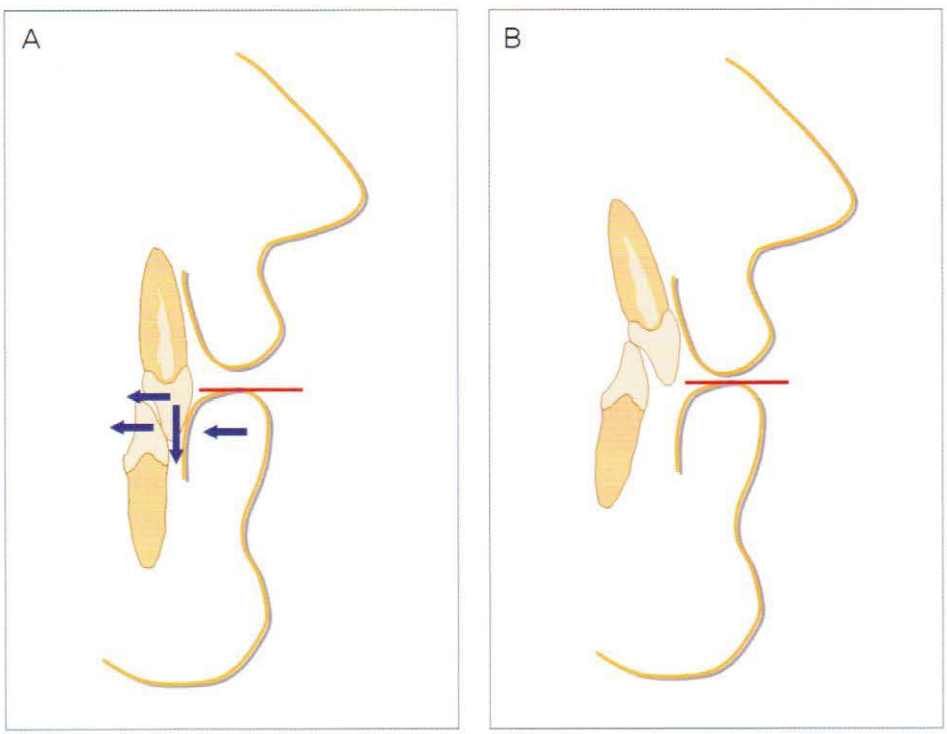


Figure 6-1-5. At rest, observe whether the deep bite patient shows lip protrusion at rest
A. Lip incompetency present. The lower lip is covering much of the upper incisor crown. The upper incisor must be intruded. This is a good case for mini-implants.
B. Lip incompetency absent. The lower lip is covering the upper incisor crown appropriately. This case must be treated with molar extrusion or lower incisor intrusion.

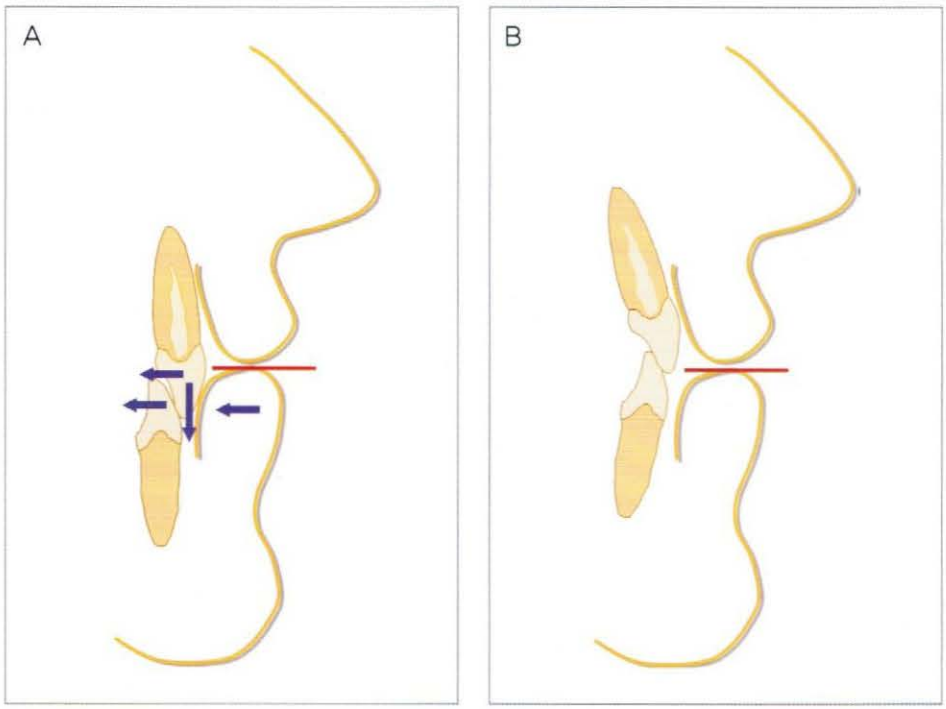


Figure 6-1-6. Observe the distance between the upper incisor and stomion.
A. This is an appropriate case for incisor intrusion.
B. Treatment should be aimed at the recovery of upper incisor-stomion distance.

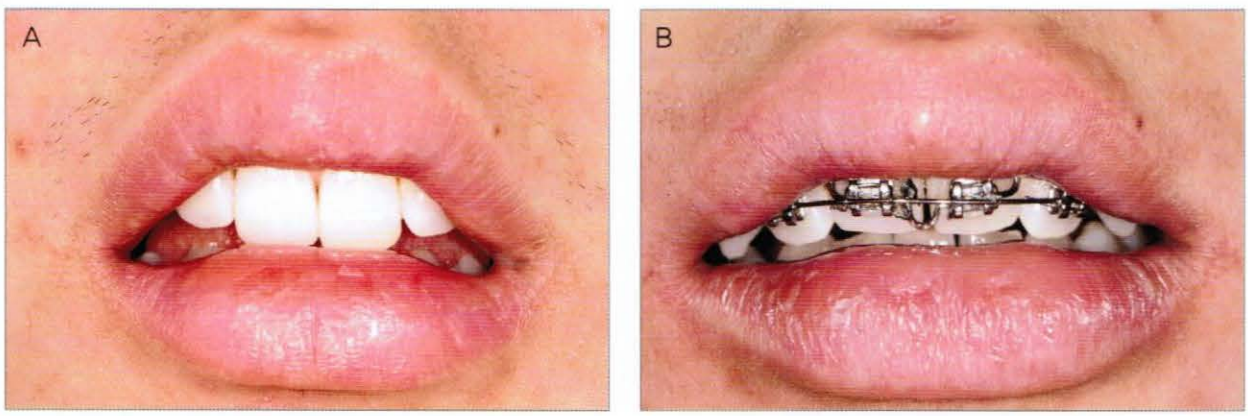


Figure 6-1-7. Photograph should be taken with the lips at rest.
A. Pre-treatment. There is lip incompetency, and the lower lip covers the upper incisors at rest.
B. Post-treatment. After intrusion of upper incisors using a mini-implant, upper incisor exposure has decreased.

Clinical tip ››››

Take photographs of the lip and upper incisor relationship at rest during deep bite treatment.

Take a photograph pre-treatment as shown in Figure 6-1-7A, then continue monitoring throughout treatment.

Ⅱ. Intrusion of lingually tipped incisors with deep overbite

■ Case 9 (Figure 6-2-1 to 28)

- Age : 10 years 6 months
- Sex : male
- Chief complaint : upper anterior crowding, gummy smile

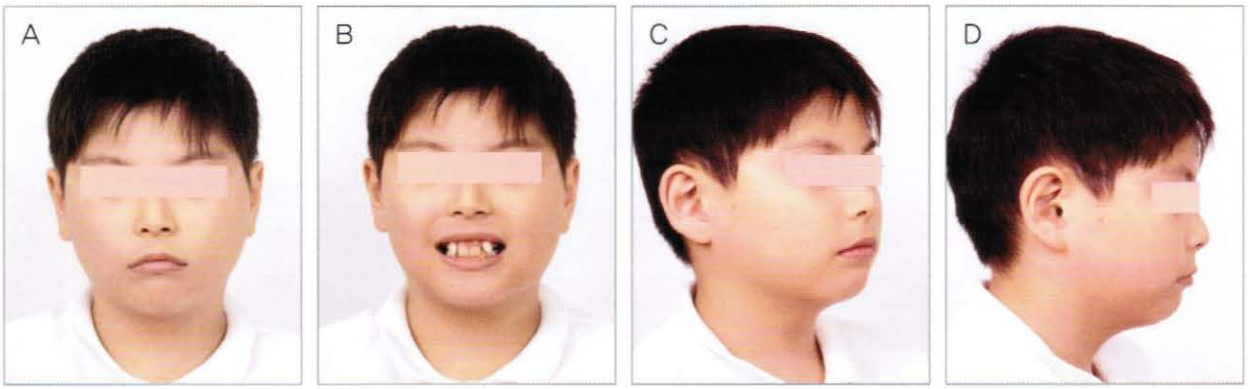


Figure 6-2-1. Pre-treatment facial photographs of Case 9
The chief complaint of the patient and parents was the severe anterior crowding and excessive gingival exposure during smile.

Figure 6-2-2. Pre-treatment intraoral photograph of Case 9
There is crowding in both the upper and lower dentition (A, F). The canine and molars show Class I relationships (B, D). Due to over-eruption of the upper incisors, the lower incisors cannot be seen (C). The upper incisors show extreme linguoversion (E).

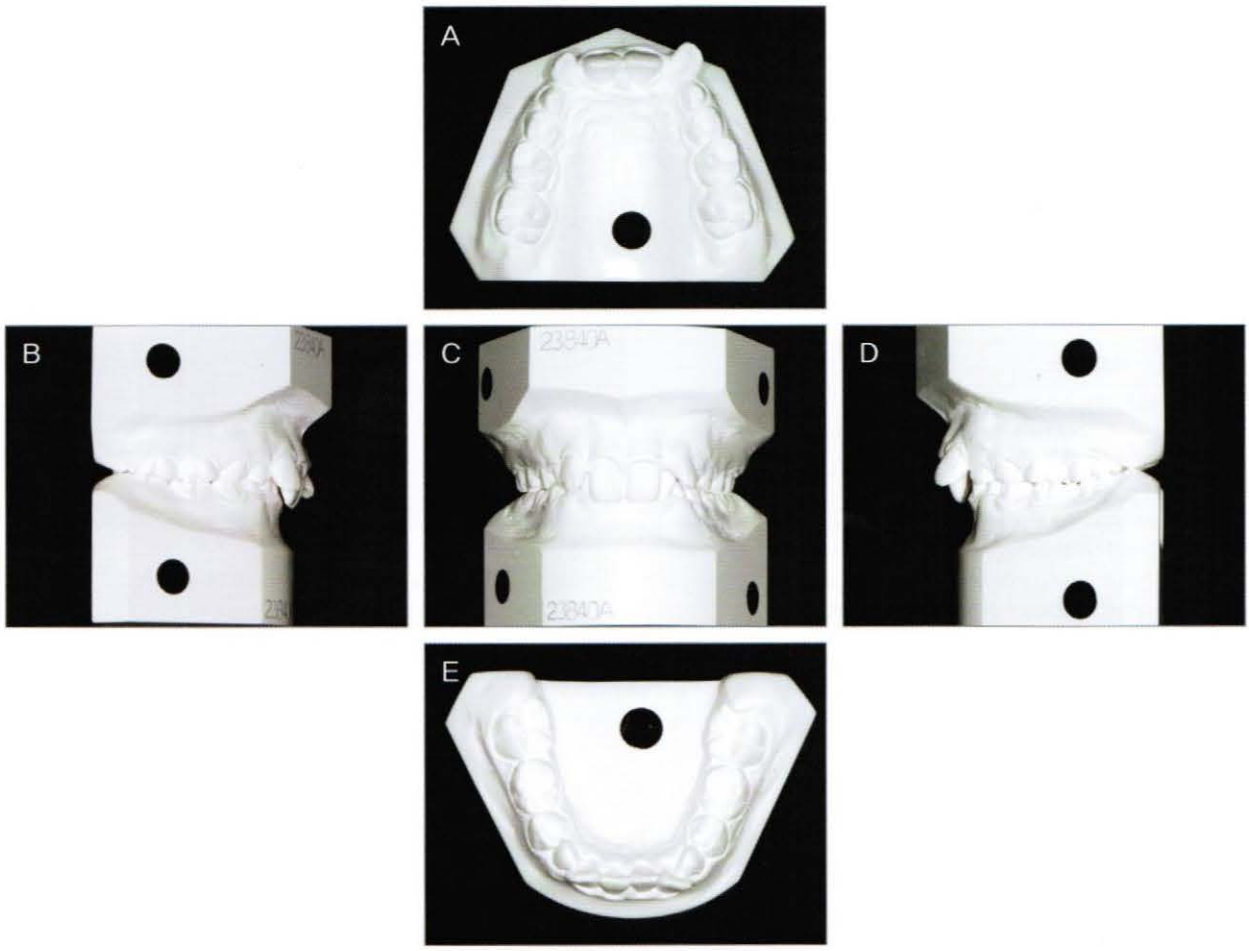
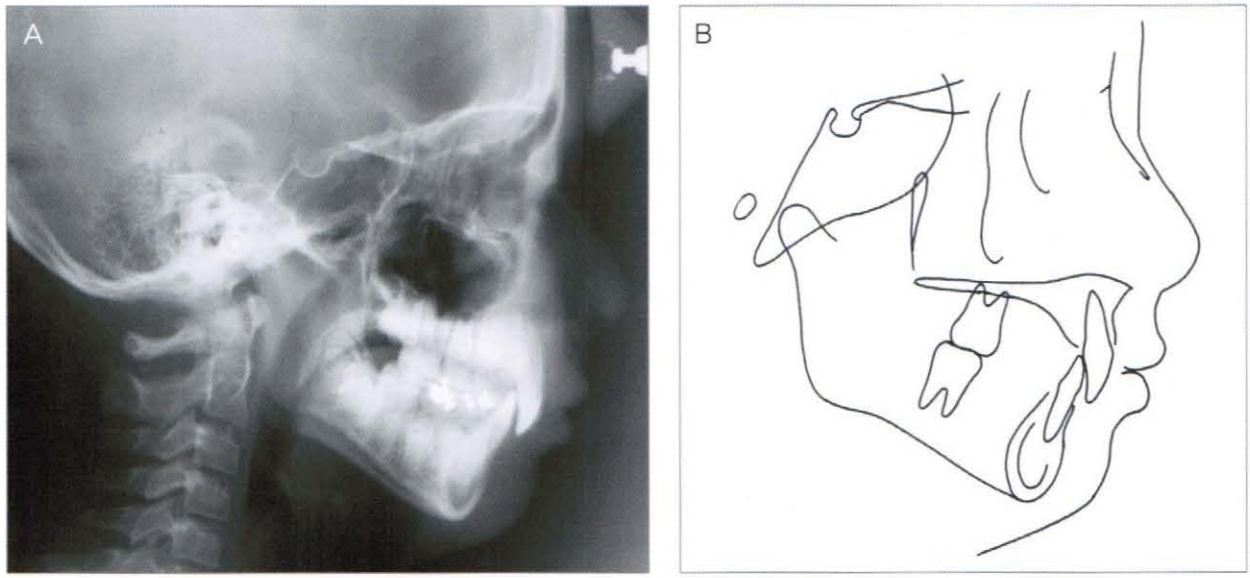


Figure 6-2-3. Pre-treatment models of Case 9
The first molars are in a Class II relationship. He shows a typical Class II division 2 malocclusion.



C

	Norm	SD	T1
SNA	82.5	3.2	83.0
SNB	80.4	3.1	74.0
ANB	2.1	1.7	9.0
FMA	22.7	5.3	28.5
U1 to FH	116.3	5.6	86.0
IMPA	96.6	6.6	79.0
IIA	124.4	8.0	159.5
Esth-U	-0.7	2.2	1.8
Esth-L	0.5	2.3	2.2

Figure 6-2-4. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. The mandible is underdeveloped. The upper incisal edge sits much lower than the lower edge of the upper lip.
B, C. The antero-posterior relationship can be said to be skeletal Class II. The upper and lower incisors show linguoversion.

Clinical tip ››››

Treatment philosophy of Class II division 2

1. Upper incisor intrusion is required.
   Looking at the cephalometric radiograph in Figure 6-2-4A, the upper incisal edge is overerupted much lower than the lower edge of the upper lip. At the 1998 American Association of Orthodontists Annual meeting, Dr. Frans P. G. M. van der Linden presented a case where long term observation of a Class II division 1 malocclusion revealed that it had relapsed into a Class II division 2 malocclusion. If treatment is finished like the patient in Figure 6-1-6A, the upper incisors will be pushed lingually and extruded into Class II division 2 due to pressure exerted by the lower lip. Therefore, the aim of Class II division 2 deep bite treatment is to intrude the upper incisors so that they are not affected by pressure from the lower lip such as in Figure 6-1-6B.
2. After treatment, the interincisal angle should be normal or overcorrected. Sufficient amount of lingual root torque must be given to the upper incisors.
3. Excessive labioversion of the lower incisors can be a cause of relapse. Severe skeletal Class II malocclusion should be treated through orthognathic surgery.
4. In growing patients with hypodivergent skeletal pattern, molar extrusion will be relatively stable, but in adults, this is a cause of relapse.

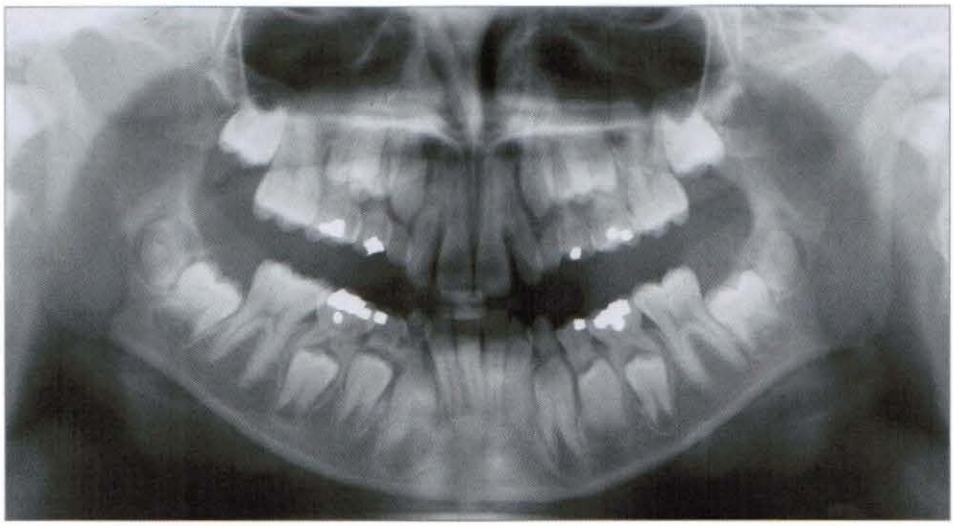


Figure 6-2-5. Pre-treatment panoramic radiograph
Mixed dentition stage with presence of all primary canines and molars.

Treatment Progress

- **Implantation**
  - 2002. 1.24 — 1.6×6.0 — 1EA 1|1
- **Intrusion of upper central incisors** — 5 months
  - 2002. 1.29 — 019×025″ ss + NiTi closed coil spring
- **Intrusion of upper lateral incisors**
  - 2002. 6.14 — Bonding on #12 & 22 014″ NiTi overlay — 2 months
  - 2002. 7.10 — 016″ ss + power chain
- **2×4 + Twin Blocks** — 6 months
  - 2002. 8.21 — Removal of mini-implant + 6|6 Band fabrication
  - 014″ ss
  - 2002. 9.11 ~ 2003. 2.25 — 018″ss
  - 2002. 11.27 ~ 2003. 2.19 — Twin Blocks + High-pull headgear
- **Leveling + Anterior inclined Plane** — 11 months
  - 2003. 2.25 ~ 2003. 7.18 — Anterior inclined plane
  - 2003. 2.25 — Full bonding (except #15 & 25) + 014″ NiTi
  - 2003. 3.21 — 016″ NiTi
  - 2003. 4.18 — 018″ NiTi
  - 2003. 6.13 — 016×022″ NiTi
  - 2003. 7.18 — Bonding brackets on #15 & 25 + U : 014″ NiTi
  - 2003. 8.13 — U : 018″ NiTi
  - 2003. 9.17 — U : 016×022″ NiTi
- **Detailing** — 6 months
  - 2003. 11.12 — 018×022″ ss with shoe hooks
  - 2004. 1.13 — 019×025″ ss with shoe hooks + crown labial torque
- **Debonding**
  - 2004. 5.7 — Class II Bionator for retention

Total 30 months

This case has the characteristics of a Class II division 2 malocclusion. First the upper central incisors were intruded, then the lateral incisors. A 2x4 appliance was used in 2 steps to prevent upper incisor extrusion, and the 4 incisors were aligned. This shows change from Class II division 1 into Class II division 2. Twin block is used for growth modification. After improvements of the antero-posterior relationship, an anterior inclined plane was used to stabilize the protracted mandible, and fixed appliances to achieve a complete occlusion. Growth modification using Twin blocks is carried out at the late mixed dentition stage. By beginning fixed appliance treatment straight after growth modification, the treatment effects of Twin block are retained through fixed appliances. Taking into account that the patient still had growth remaining, a Bionator was used instead of removable retainers.

Clinical tip ››››

The most important step in treatment of Class II division 2 malocclusion

Relieve crowding of the upper incisors and convert into Class II division 1. The overerupted and lingually inclined upper incisor in Case 9 has been intruded and inclined labially into Class II division 1.

Clinical tip ››››

What is the best time for growth modification of Class II treatment?

At the late mixed dentition stage when around 4 primary molars remain. Recent studies indicate that starting Class II treatment too early will increase total treatment time, and the growth modification effect will be lost before fixed appliance treatment is begun.

Figure 6-2-6. Surgical procedure
The labial frenum has a low insertion (A). Incise as in a frenotomy, raise a flap and expose the periosteum (B). The mini-implant is inserted as high as possible (C). At first the mini-implant head was to be exposed into the oral cavity, but the patient complained of discomfort. With healing, the head of the mini-implant was covered by soft tissue (Figure 6-2-8G) and the patient no longer complained. In subsequent cases, the head was no longer exposed, but covered with the soft tissue flap at the initial operation. Before suturing the flap closed, NiTi closed coil spring is ligated onto the head of the mini-implant.

Clinical tip ››››

When inserting a mini-implant in the interradicular space between the two central incisors, will the head be left exposed? Or covered with the flap and only the spring exposed? ('open type' vs. 'closed type')

Insert the mini-implant as close to the anterior nasal spine as possible between the central incisor roots. Ligate NiTi closed coil spring onto the head, close the flap and suture ('closed type').

If the mini-implant is inserted too low in the gingiva to be able to leave the head exposed, the range of action of the spring will be too short. Also because the interradicular space is too narrow, incisor intrusion will cause the mini-implant to come in contact with the root, and cause subsequent failure. Therefore using the closed type will decrease patient discomfort and allow the spring a longer range of action. The only disadvantage is that a second procedure is required for removal of the mini-implant.

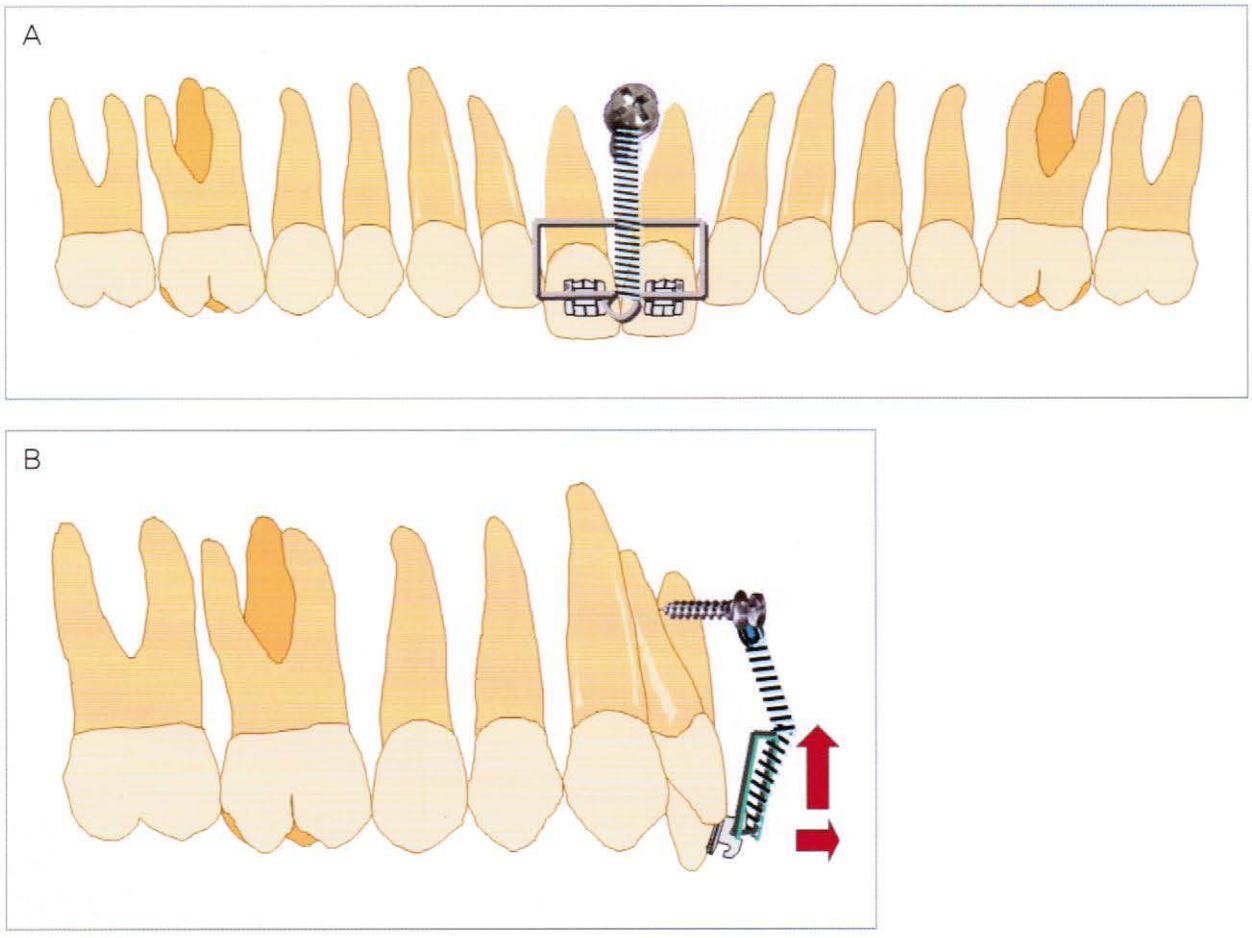
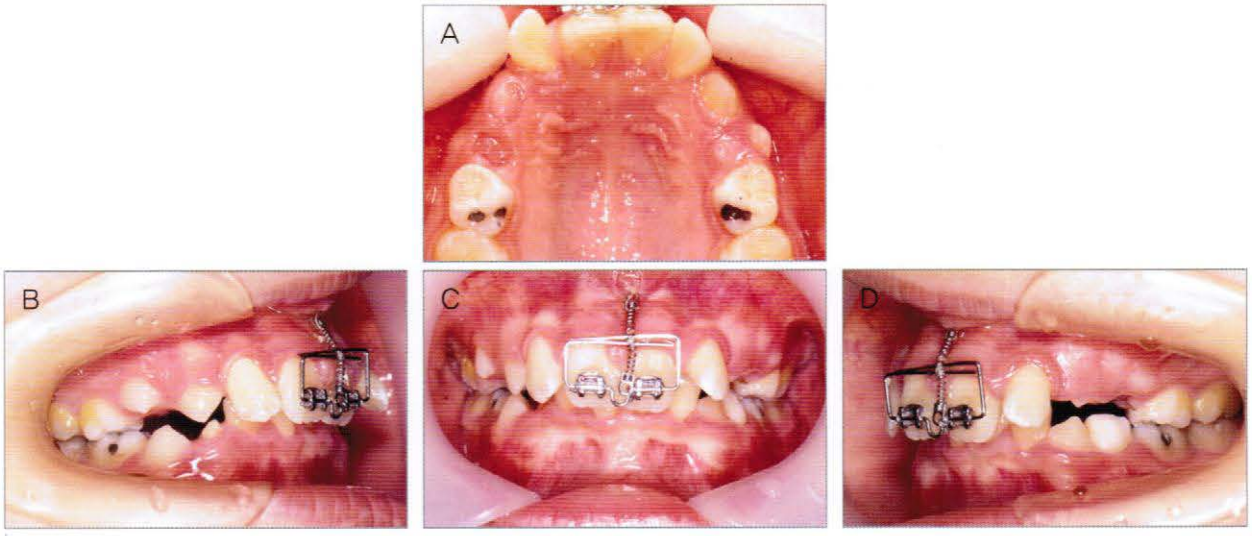


Figure 6-2-7. Illustration of upper incisor intrusion mechanics
A. 019×025″ ss wire is inserted onto two brackets (022″ slot) in a box form. This acts as a guiding wire.
B. This guiding wire prevents the NiTi closed coil spring from impinging on the gingiva. The upper incisors will be intruded and inclined labially. This method has been improved from Dr. Creekmore's clinical paper.



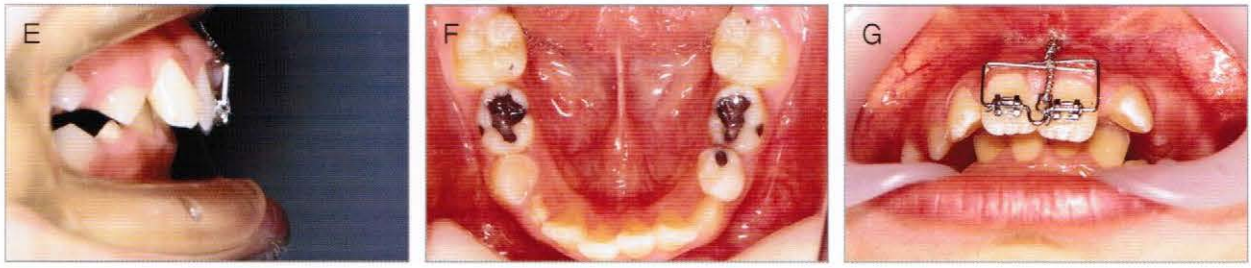


Figure 6-2-8. Three months after intrusion of upper central incisors (2002. 4.10)
With intrusion of the upper central incisors for 3 months, the lower incisors are starting to become visible. The exposed mini-implant has become covered with soft tissue during the healing process. If the mini-implant is inserted in the movable mucosa, ulceration or hyperplasia will occur and cause inflammation and discomfort for the patient. Nowadays, the mini-implant head is always covered with the flap in a closed type.

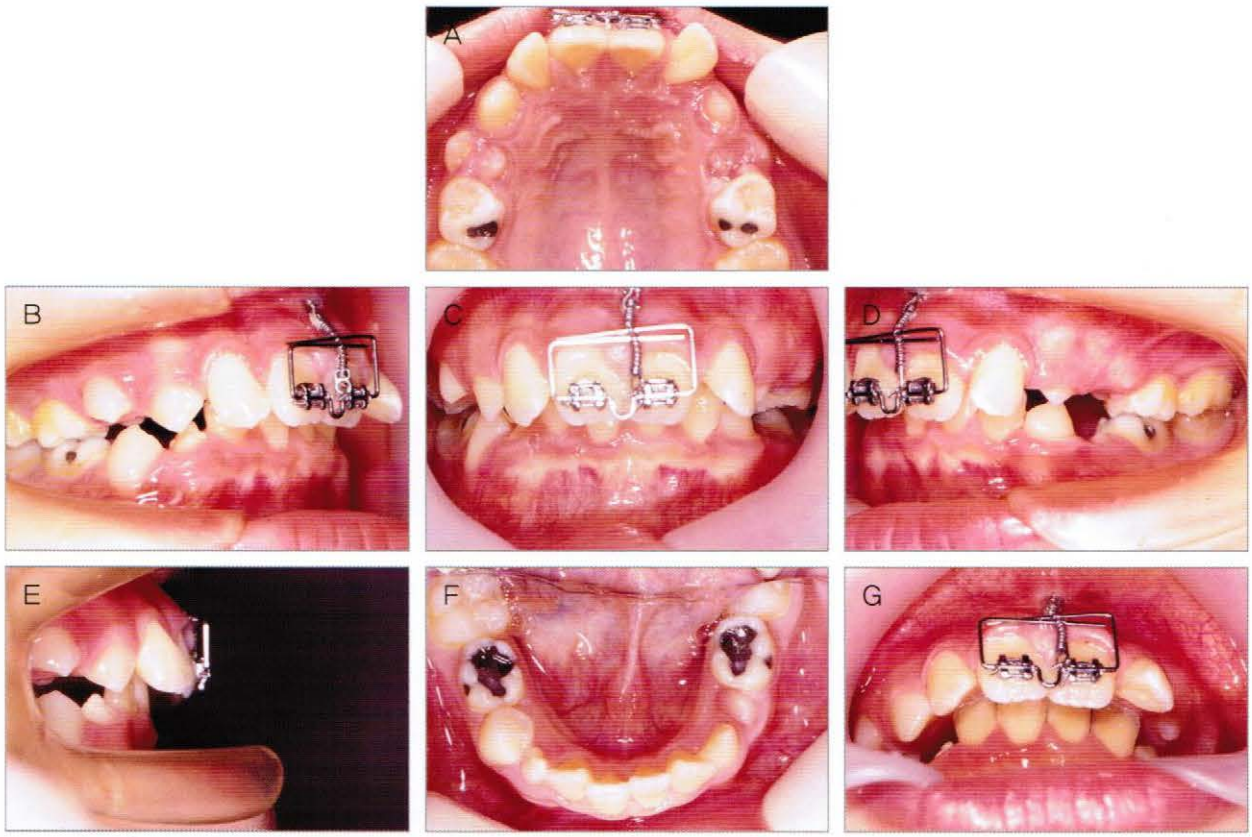


Figure 6-2-9. Four months after central incisor intrusion (2002. 5.8)

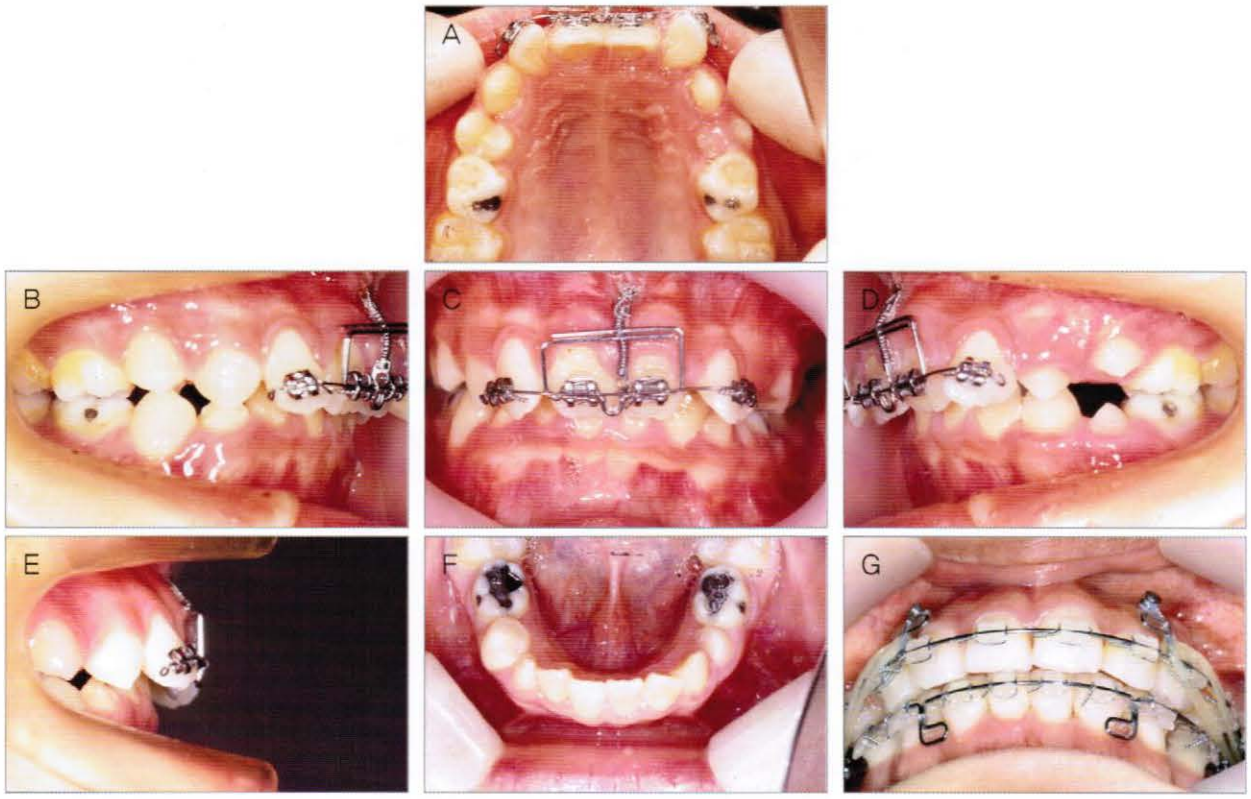


Figure 6-2-10. Five months after central incisor intrusion (2002. 6.16)
When the central incisors were intruded to the same level of the lateral incisors, the lateral incisors were also bonded. 014″ NiTi wire is overlaid.

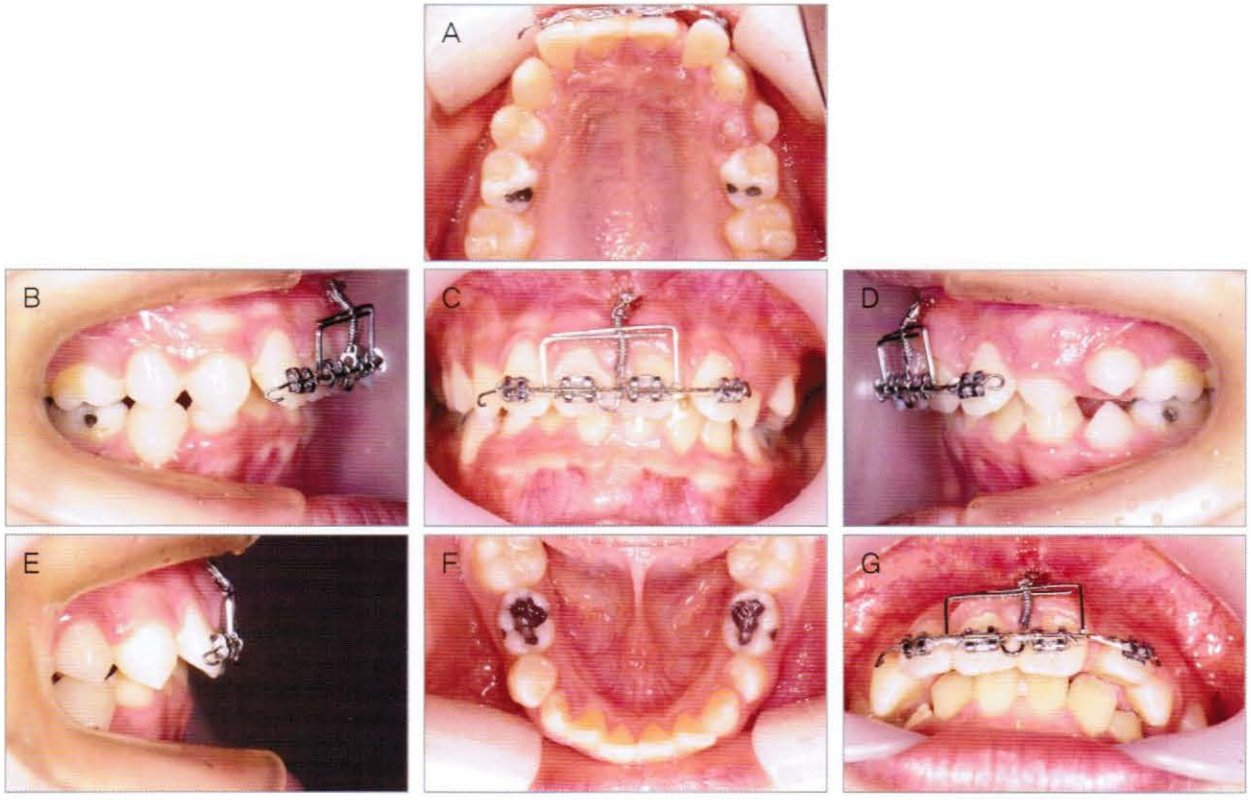


Figure 6-2-11. Six months after incisor intrusion (2002. 7.13)
018″ ss wire is overlaid. Half of the lower incisors can be seen.

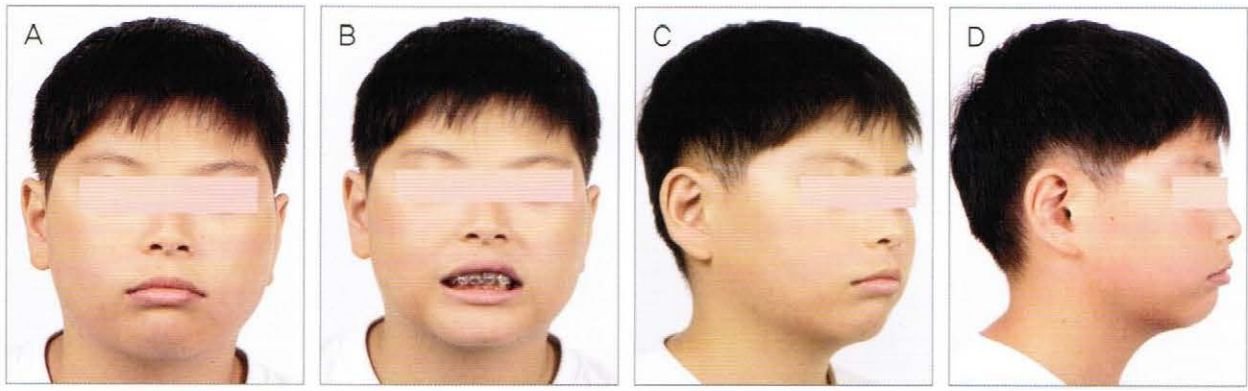
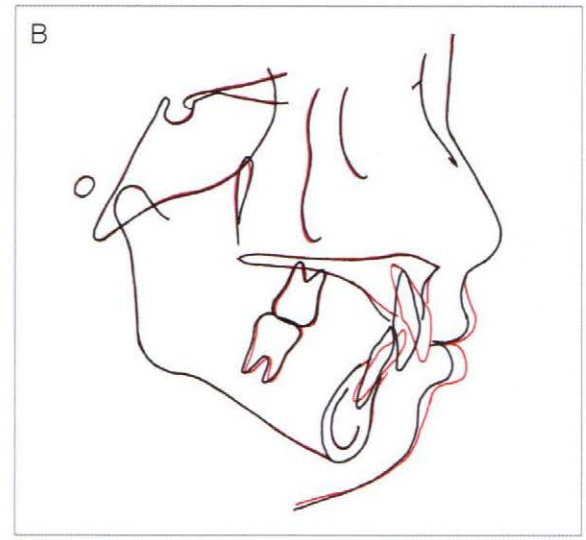
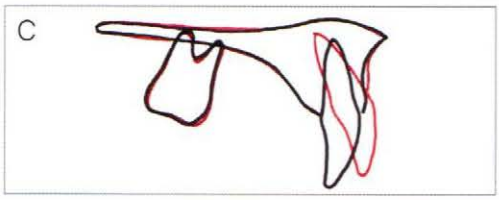
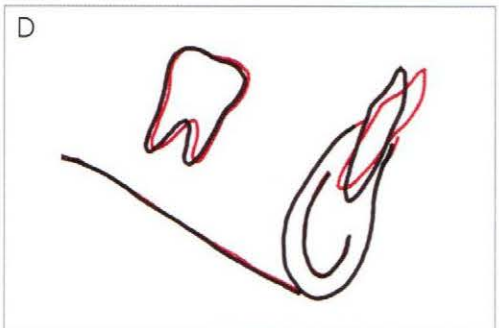


Figure 6-2-12. Facial photograph after 6 months of upper 4 incisor intrusion (2002. 7.13)
Upper incisor exposure has been reduced on smiling (B). Due to intrusion and labial inclination of the upper incisors, the upper and lower incisors both look protruded than before treatment (C, D).







E

	Norm	SD	T1	T2
SNA	82.5	3.2	83.0	85.0
SNB	80.4	3.1	74.0	75.0
ANB	2.1	1.7	9.0	10.0
FMA	22.7	5.3	28.5	26.0
U1 to FH	116.3	5.6	86.0	104.0
IMPA	96.6	6.6	79.0	96.0
IIA	124.4	8.0	159.5	136.5
Esth-U	-0.7	2.2	1.8	2.0
Esth-L	0.5	2.3	2.2	5.9

Figure 6-2-13. Cephalometric radiograph and measurement after intrusion of upper 4 incisors
A. On cephalometric radiograph, it can be seen that there is labioversion and intrusion of the upper incisors. There is mouth protrusion.
B. Superimposition shows labioversion and intrusion of the upper incisors. An interesting observation is that the lower incisors have been labially inclined even though no orthodontic force has been applied.
C. Sectional superimposition of the maxilla. The upper incisors have been intruded and labially inclined.
D. Sectional superimposition of the mandible. There has been natural labial inclination of the lower incisors.
E. Measurement. T1 is pre-treatment, T2 is after upper incisor intrusion. It is interesting to see that IMPA has increased from 79° to 96°.

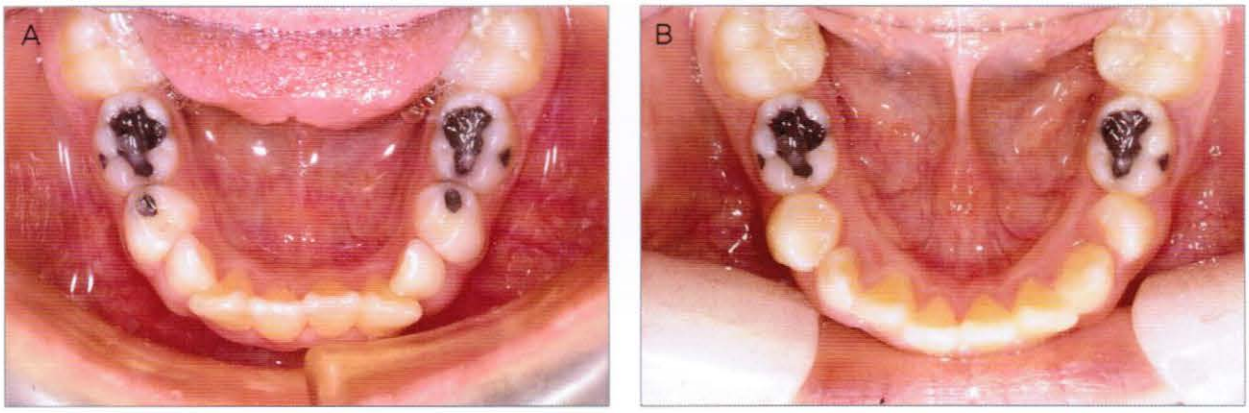


Figure 6-2-14. Changes in the lower arch after upper incisor intrusion
A. The lower arch before treatment
B. After intrusion of the upper incisors. Without the use of any orthodontic appliances, the lower arch shows expansion with labioversion and relief of crowding of the lower incisors.

Clinical tip ››››

Treatment of crowding in Class II division 2 deep bite

Treat lower arch crowding after intrusion and labioversion of the upper incisors. As seen in Case 9 Figure 6-2-13 and 14, natural labioversion and relief of crowding occurs. There is no need to bond the lower arch early and force crowding relief. In addition, there is no room for bracket bonding. Also, wait on the decision to extract for lower crowding relief until after upper incisor labioversion and intrusion have occurred.

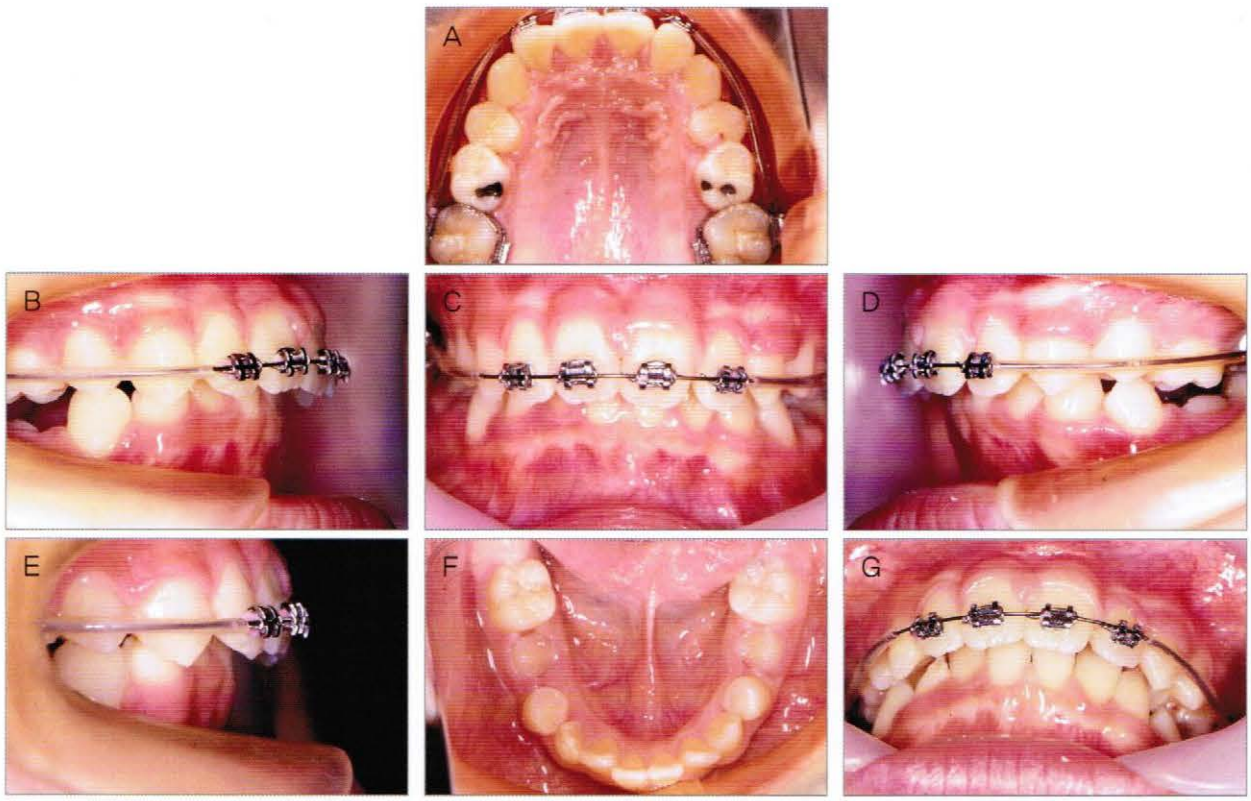


Figure 6-2-15. Intraoral photograph after fitting bands on the upper first molars (2002. 8.21)
The bands have been fitted to prevent extrusion of the upper 4 incisors. The mini-implant was removed after 2×4 appliance was inserted.

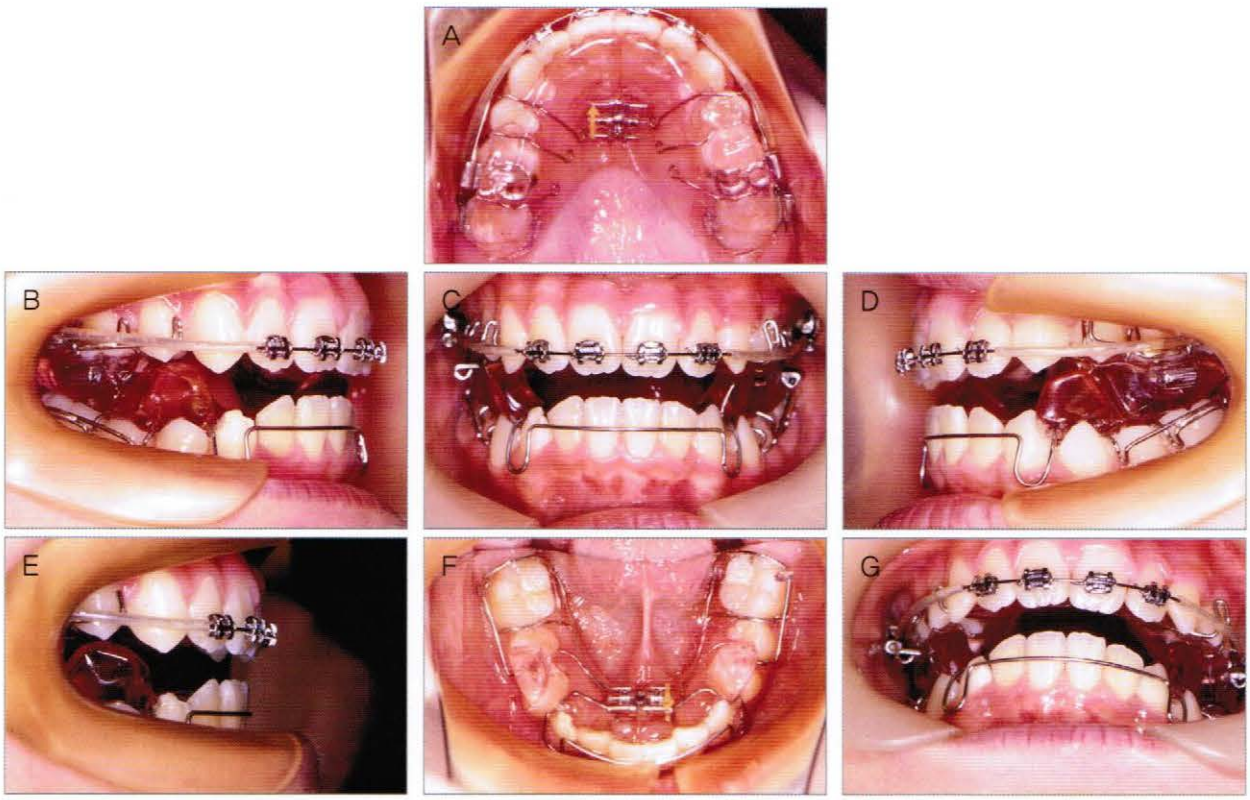


Figure 6-2-16. Intraoral photograph after Twin Block insertion (2002. 11.27)
For slight expansion of the upper arch, an expansion screw has been inserted. This will be used to relieve the slight crowding in the lower arch.

Figure 6-2-17. High-pull headgear used with Twin Blocks For inhibition of vertical and anterior growth of maxilla.

Indications of Twin Blocks

- As Dr. Clark mentioned, the most straight forward case for Twin Blocks displays the following criteria,

1. Class II division 1 with good arch form
2. A lower arch that is uncrowded or decrowded and aligned.
3. An upper arch that is aligned or can be easily aligned.
4. An overjet of 10-12 mm and a deep overbite
5. A full unit distal occlusion in the buccal segments.
6. On clinical examination the profile is noticeably improved when the patient advances the mandible voluntarily to correct the overjet.

Case 9 shows that a Class II division 2 has changed to a Class II division 1 from upper incisor intrusion and labioversion. It now has the indications for use of Dr. Clark's Twin block appliance.

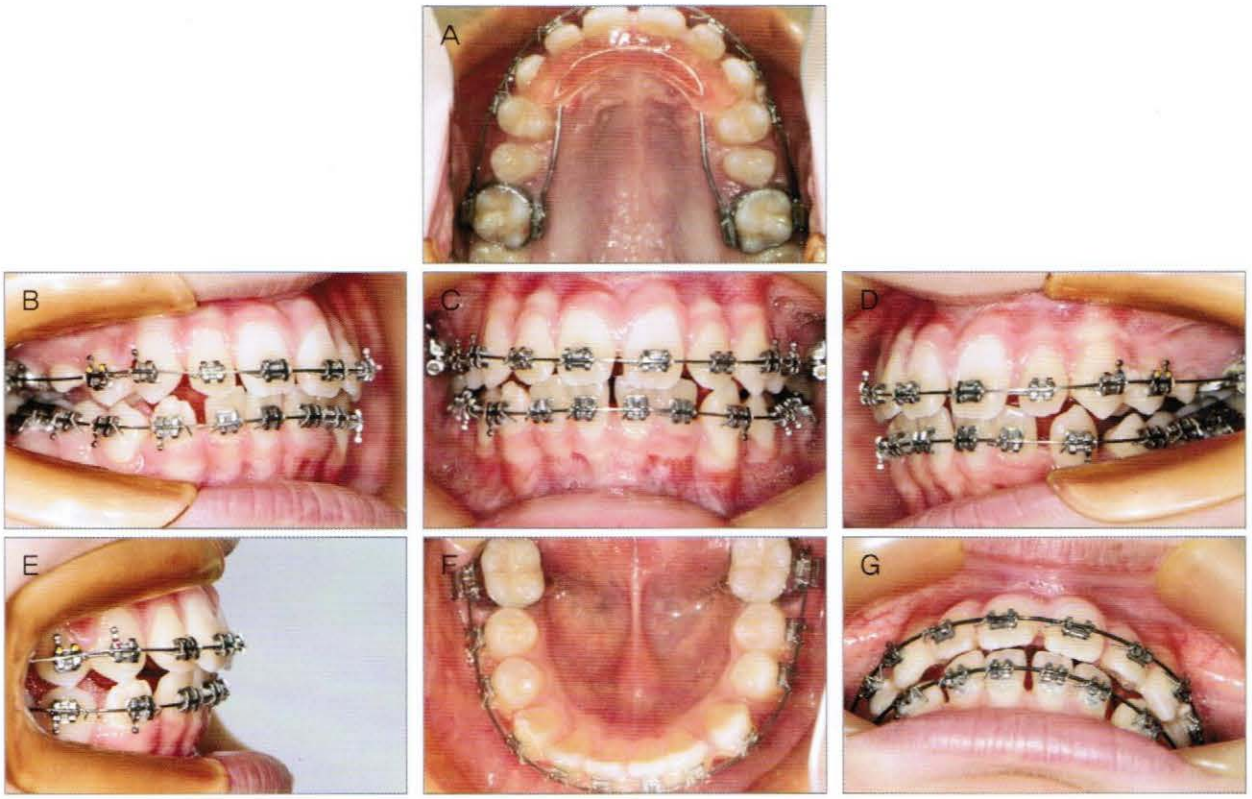


Figure 6-2-18. With an anterior inclined plane in place, all teeth were bonded with brackets (2003. 6.13)
After expansion of Twin blocks, spacing actually occurred in both arches. Treatment was completed using fixed appliances. At the last stage, upper incisors were given root lingual torque using 019×125" ss with shoe hooks.

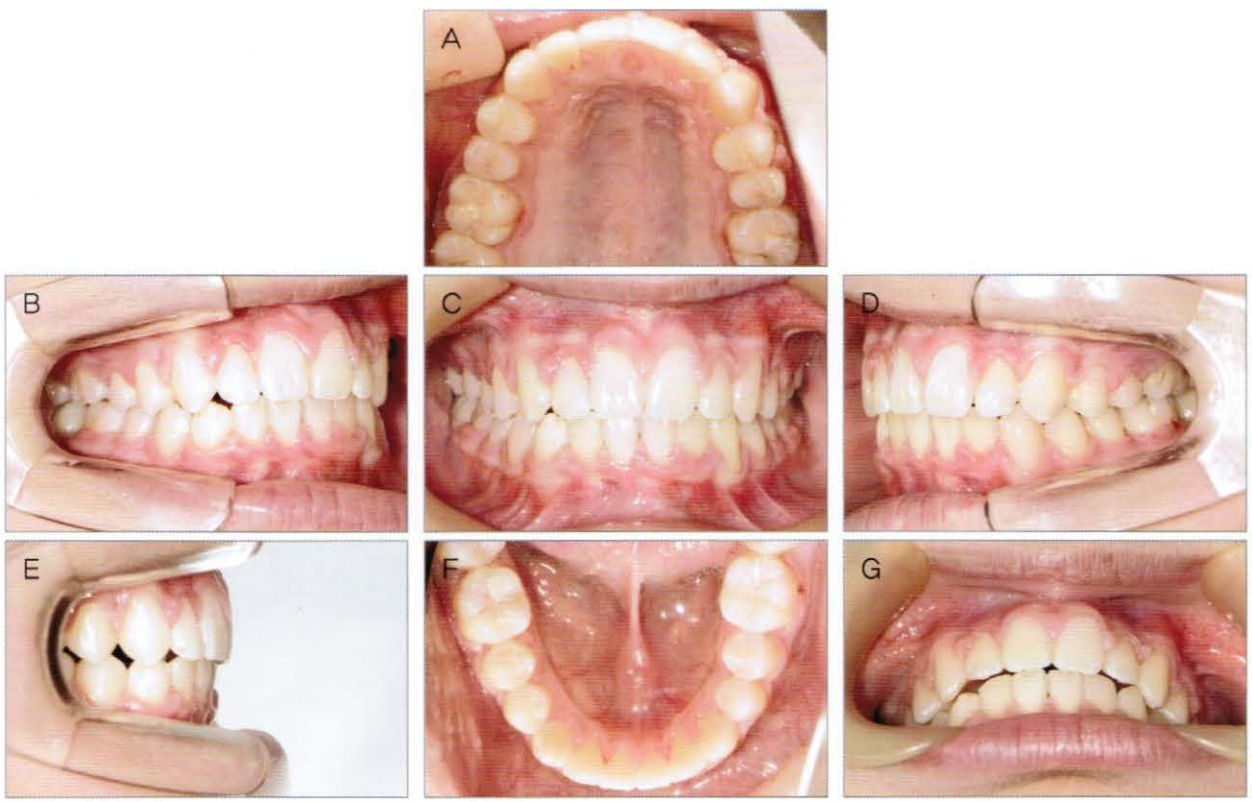


Figure 6-2-19. Intraoral photograph at debonding (2004. 5.7)
As much as the deep bite was severe pre-treatment, overcorrection was performed.

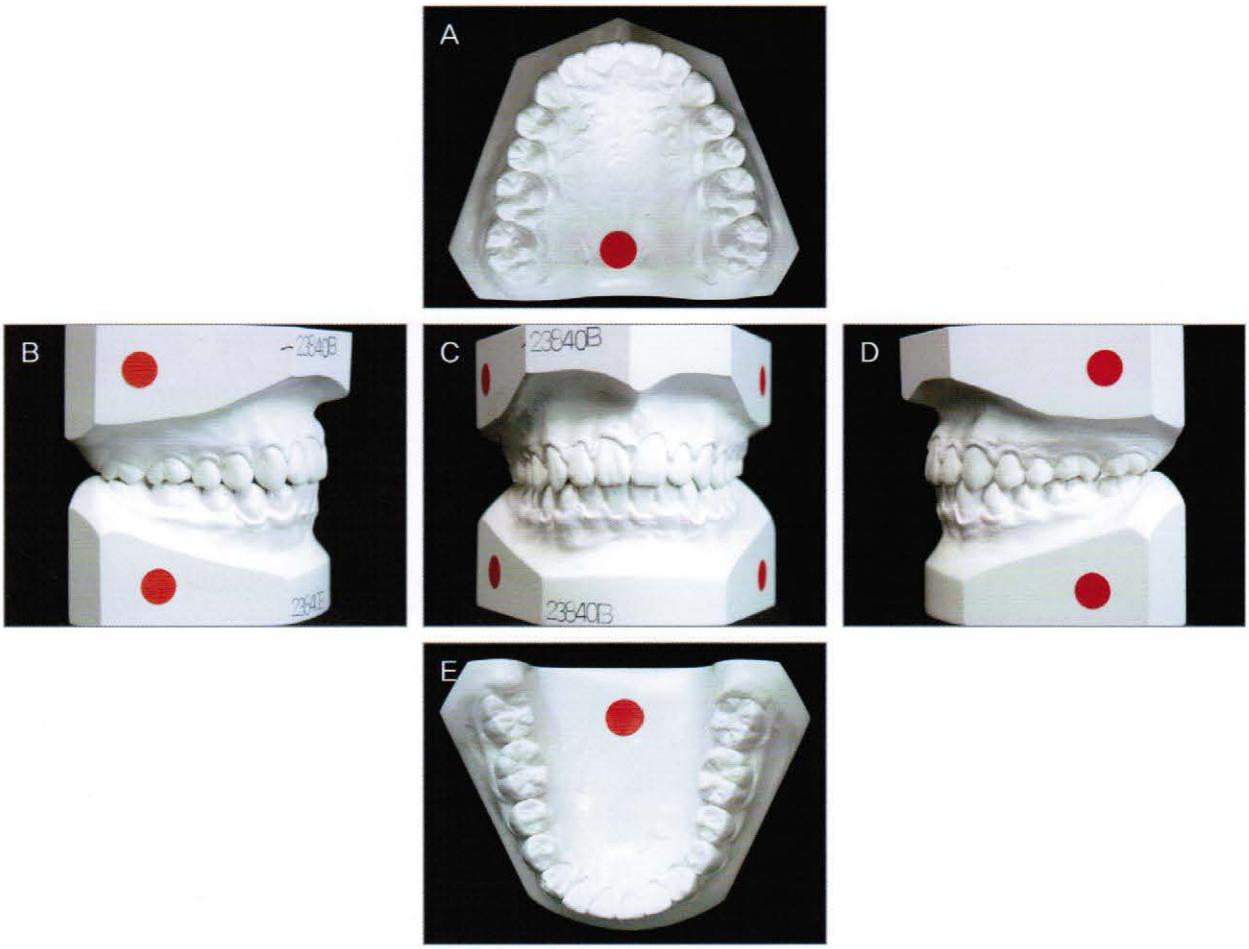


Figure 6-2-20. Post-treatment models of Case 9
The molars show a Class I relationship.

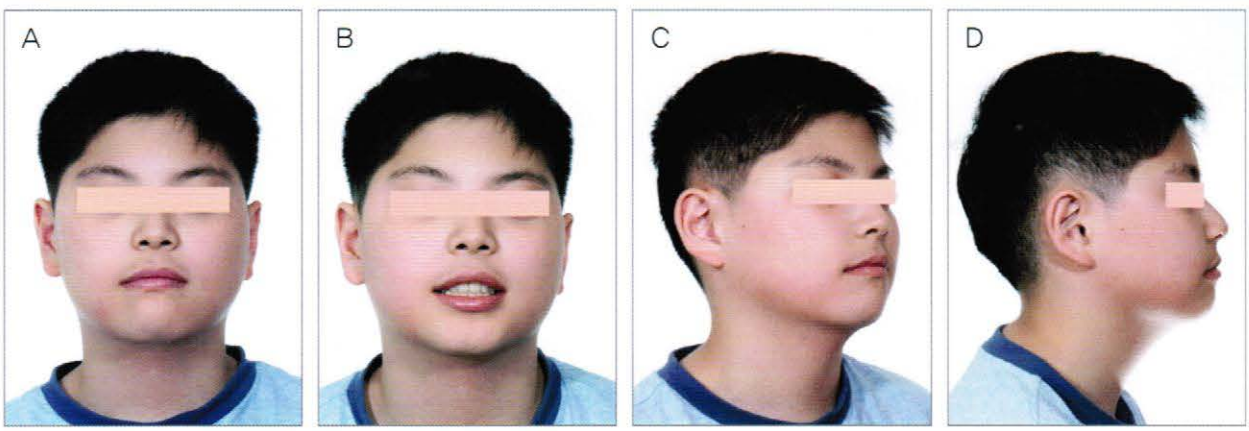
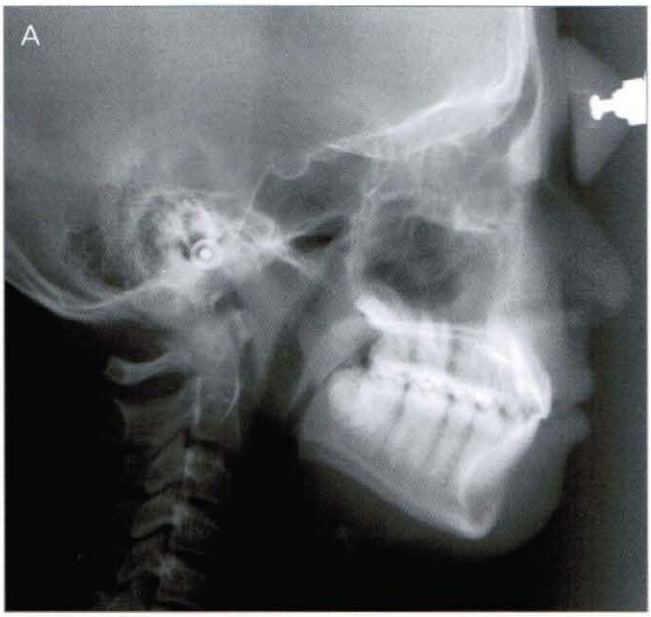
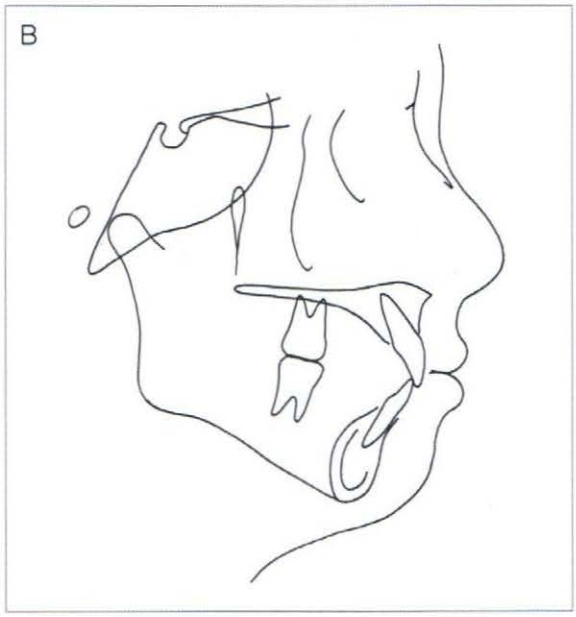
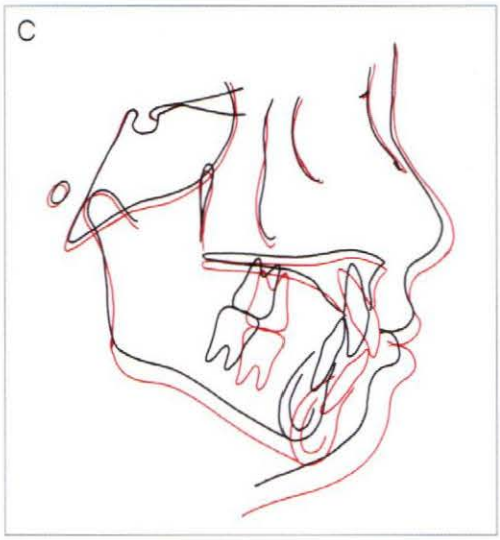


Figure 6-2-21. Facial photographs at debonding (2004. 5.7)
Gummy smile has disappeared, and with growth of the mandible, shows an esthetic profile.







D

	Norm	SD	T1	T2	T3
SNA	82.5	3.2	83.0	85.0	82.5
SNB	80.4	3.1	74.0	75.0	76.0
ANB	2.1	1.7	9.0	10.0	6.5
FMA	22.7	5.3	28.5	26.0	27.5
U1 to FH	116.3	5.6	86.0	104.0	109.5
IMPA	96.6	6.6	79.0	96.0	100.5
IIA	124.4	8.0	159.5	136.5	124.0
Esth-U	−0.7	2.2	1.8	2.0	−0.5
Esth-L	0.5	2.3	2.2	5.9	2.0

Figure 6-2-22. Cephalometric radiograph and measurement at debonding
A. Post-treatment cephalometric radiograph
B. Post-treatment tracing
C. Superimposition of pre- and post-treatment profile. Growth of the mandible has helped produce an esthetic profile.
D. T1 is pre-treatment, T2 is after intrusion and labioversion of upper incisors, and T3 is after debonding.

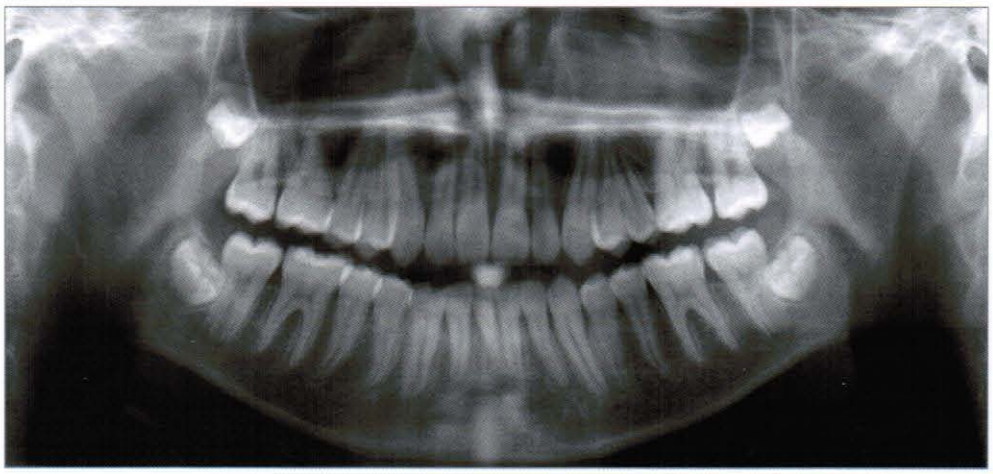


Figure 6-2-23.
Panoramic radiograph at debonding
No root resorption was noted.

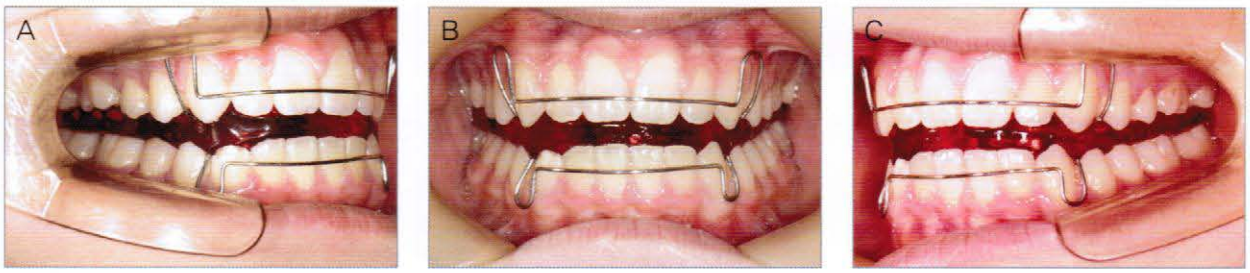


Figure 6-2-24. Class II Bionator was used for retention.

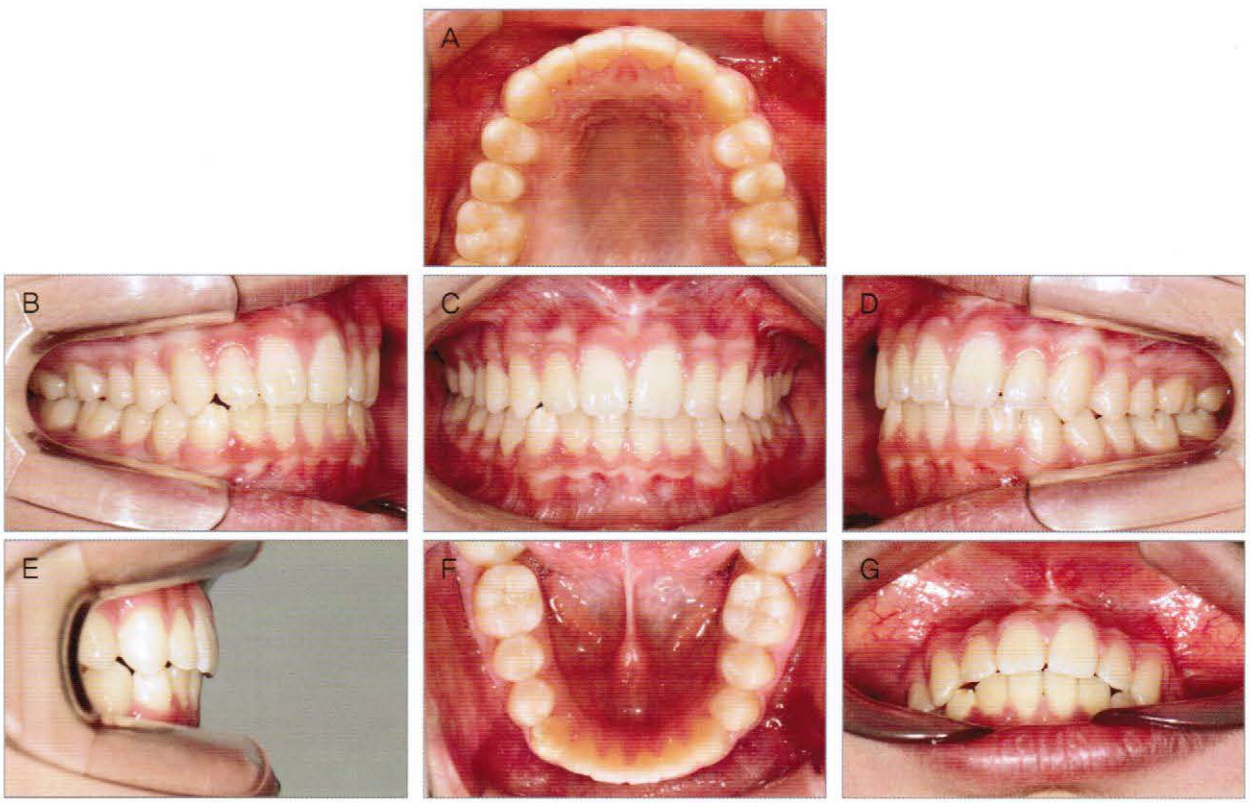


Figure 6-2-25. Intraoral photograph 1 year post-retention (2005. 4.3)
He shows a stable occlusion.

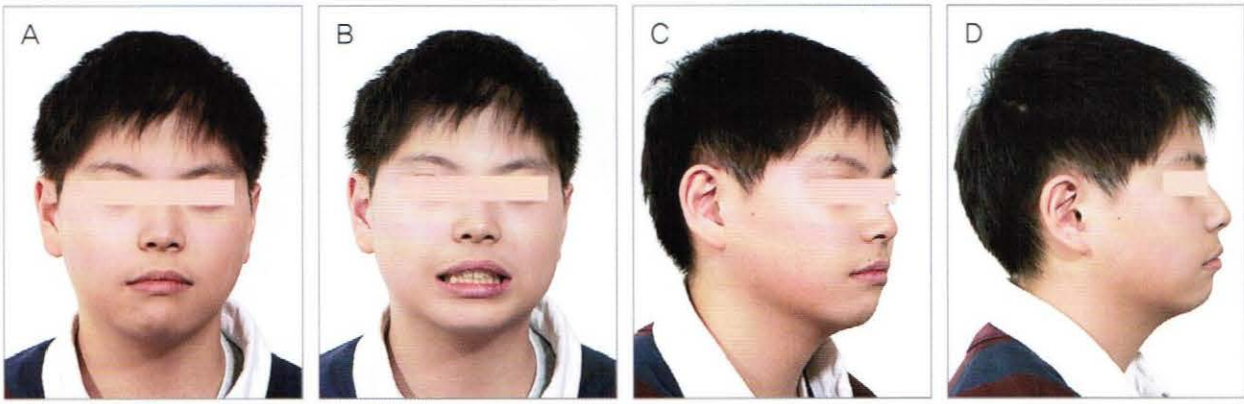


Figure 6-2-26. Facial photograph 1 year post-retention (2005. 4.3)

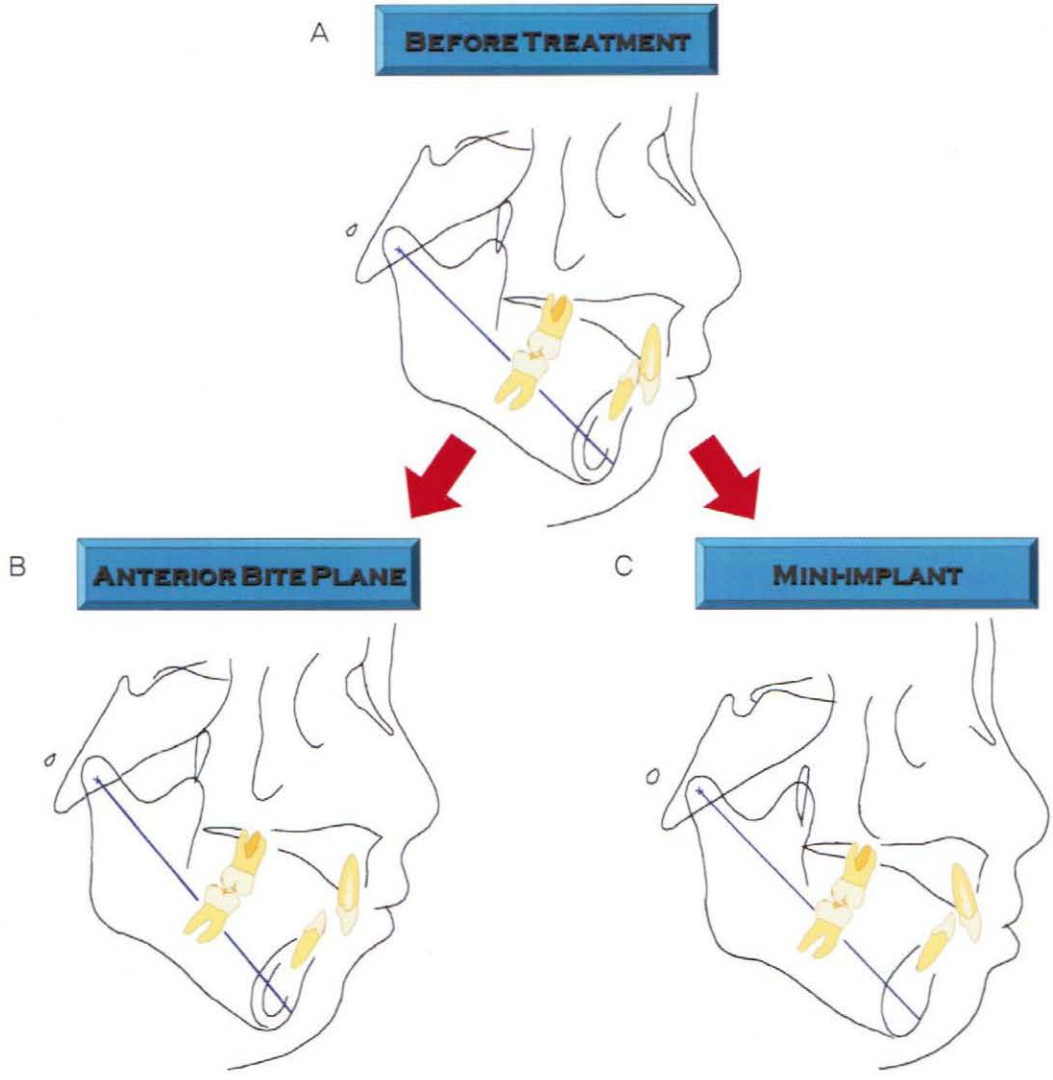


Figure 6-2-27. Comparison of treatment effects from molar extrusion and incisor intrusion

A. Pre-treatment

B. Changes after upper molar intrusion through use of anterior bite plane
Usually in deep bite patients, fixed appliances are bonded with an anterior bite plane inserted. In these cases, the mandible rotates clockwise and both B point and pogonion point move back further. This is unfavorable esthetically. The antero-posterior relationship will become worse.

C. In Case 9, without the use of an anterior bite plane, the upper incisors were intruded and labially inclined. Clockwise rotation of the mandible does not occur. Crowding of the lower incisors was relieved naturally.

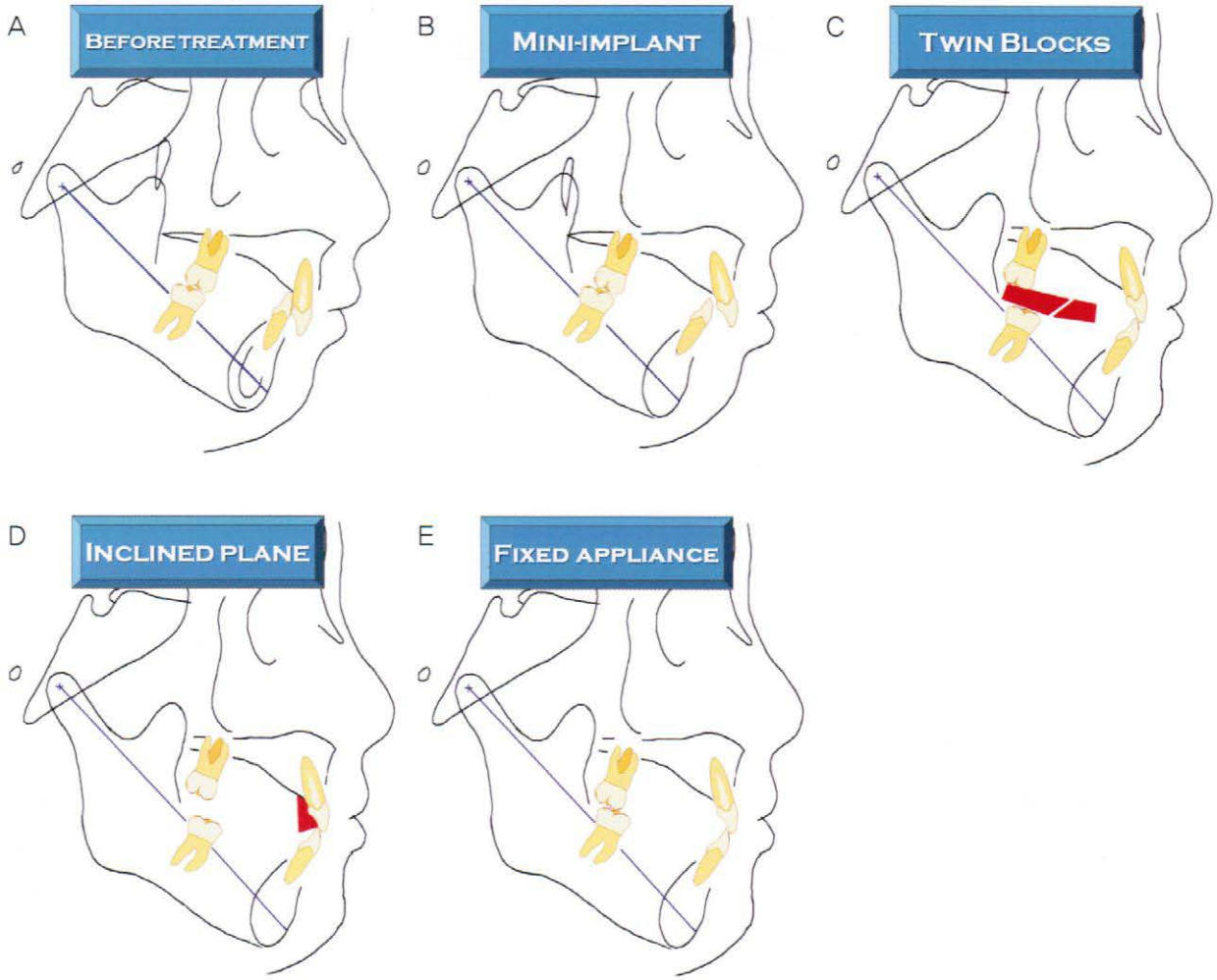


Figure 6-2-28. Summary of treatment process
A. Pre-treatment
B. After mini-implant use
C. After use of Twin block appliance
D. After use of anterior inclined plane
E. After completion of fixed appliance treatment

References

1. Creekmore TM, Eklund MK. The possibility of skeletal anchorage. J Clin Orthod 1983;17:266-9.
2. Clark WJ. Twin block functional therapy, Applications in dentofacial orthopaedics, London : Mosby-Wolfe : 1995. p23.

■ Case 10 (Figure 6-3-1 to 27)

- Age : 20 years 6 months
- Sex : male
- Chief complaint : facial asymmetry, left TMJ sound, severe display of upper incisors

  After consult with the oral surgeon, he came for pre-surgical orthodontic treatment.

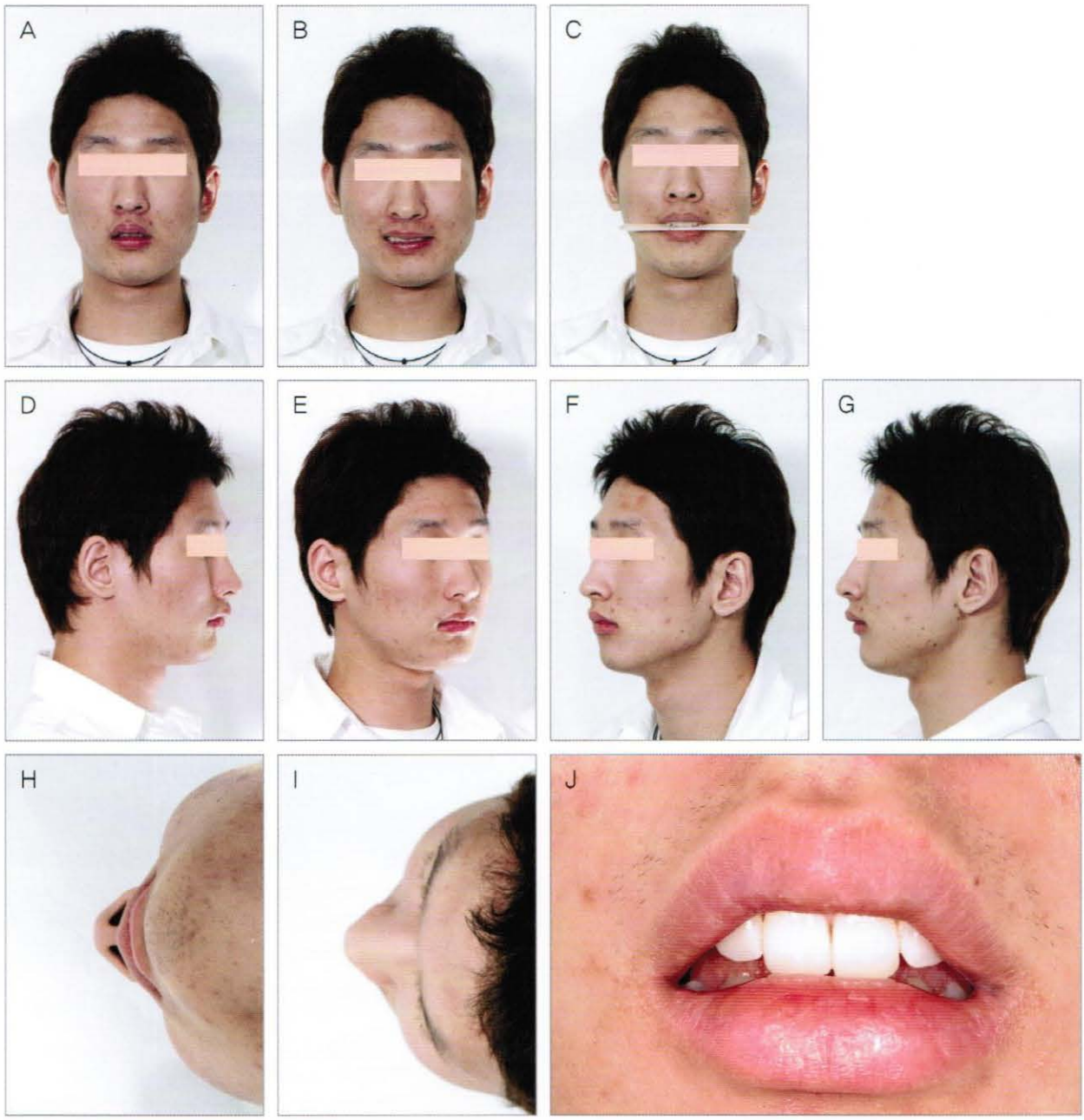


Figure 6-3-1. Pre-treatment facial photograph of Case 10
The patient's chief complaint was facial asymmetry and overexposure of the upper incisors. The left mandibular angle looks prominent (A, B). There is no canting of the occlusal plane (H, I). The upper incisors show overexposure (J). The lips need to be opened more than rest state to be able to see the upper incisal edge.

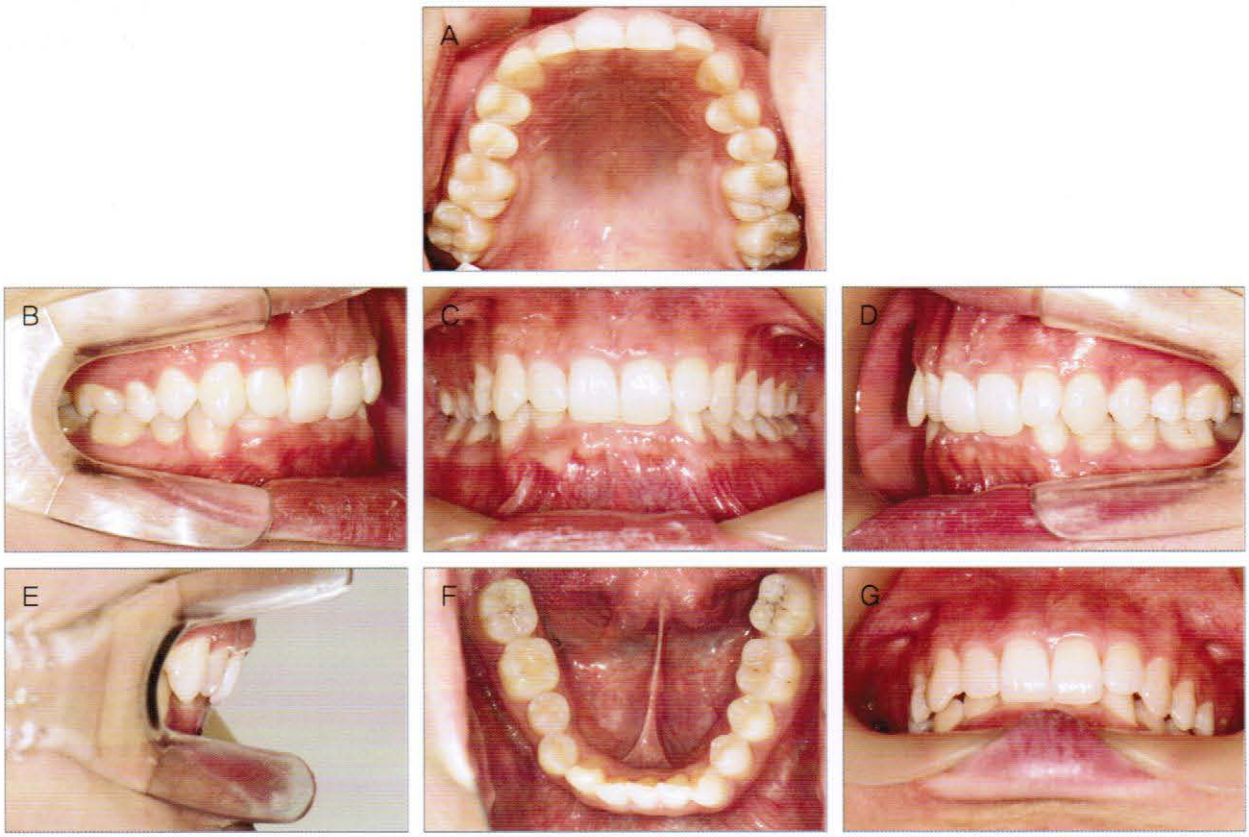
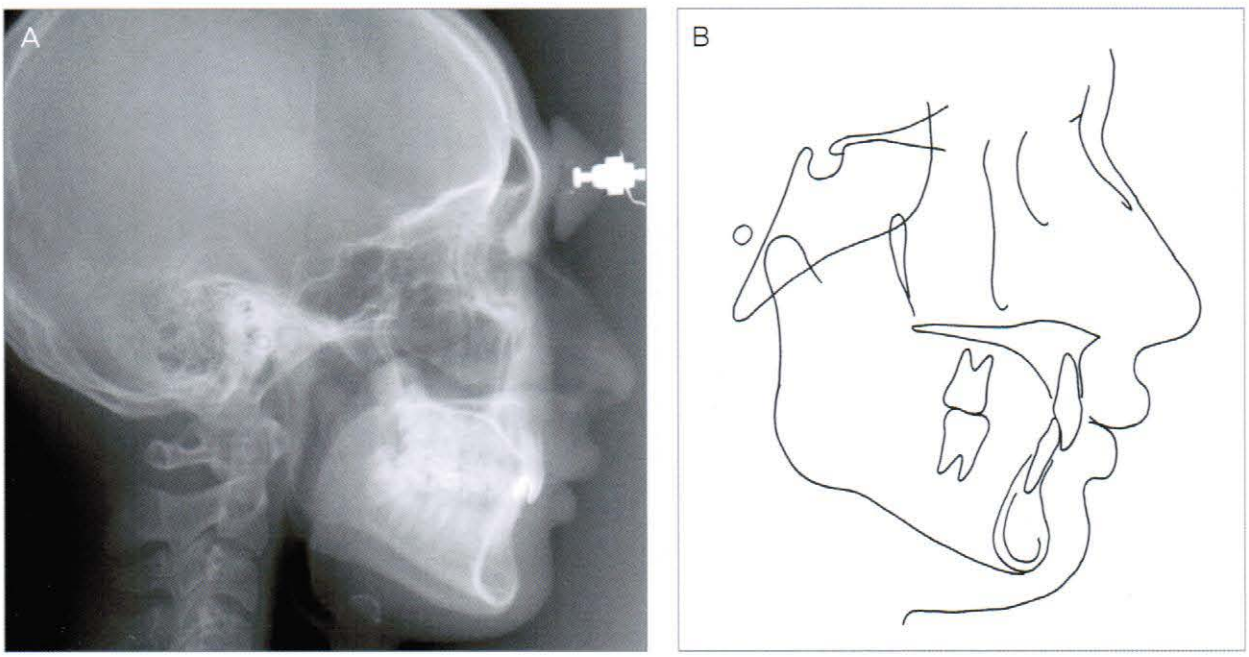


Figure 6-3-2. Pre-treatment intraoral photographs of Case 10
There is slight crowding in both arches (A, F). There are three lower incisors (F). The canine and first molars show Class I relationships (B, D). The lower incisors cannot be seen due to the overerupted upper incisors (C). The upper central incisors show severe linguoversion (E).



C

	Norm	SD	T1
SNA	82.5	3.2	78.2
SNB	80.4	3.1	73.0
ANB	2.1	1.7	5.2
FMA	22.7	5.3	24.4
ODI	73.3	5.9	84.3
U1 to FH	116.3	5.6	87.8
IMPA	96.6	6.6	85.8
IIA	124.4	8.0	162.1
Esth-U	-0.7	2.2	-0.1
Esth-L	0.5	2.3	-2.4

Figure 6-3-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. The mandible is underdeveloped. The upper central incisal edge is placed much further down than the upper lip.
B, C. The antero-posterior skeletal pattern is Class II. Both upper and lower incisors show linguoversion. He shows a deep bite skeletal pattern (Hypodivergent skeletal pattern).

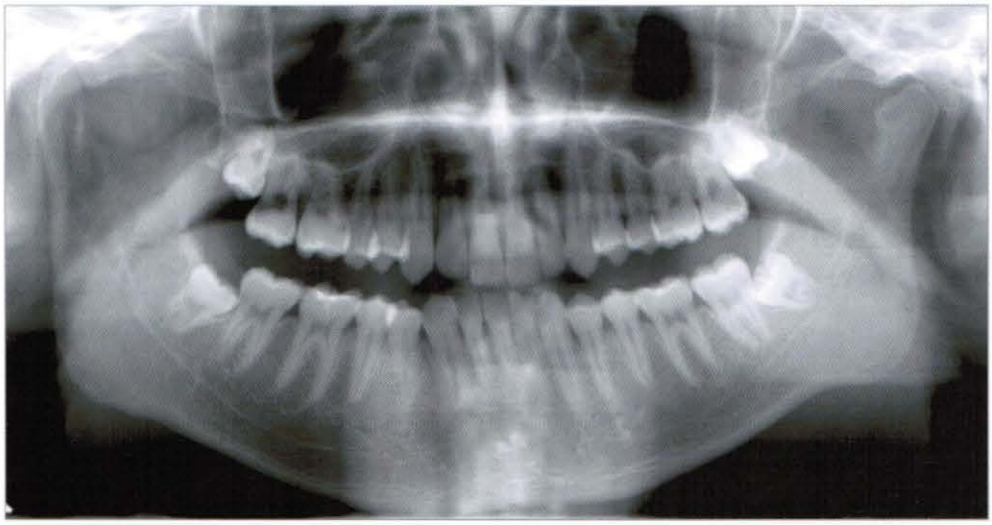


Figure 6-3-4. Pre-treatment panoramic radiograph
All the third molars were extracted before beginning treatment. There has been deformation of the left condyle. The left TMJ showed clicking, and there is past history of headaches and locking. There are only three lower incisors. The lower incisors show linguoversion.

Figure 6-3-5. Pre-treatment postero-anterior radiograph
The mandible is displaced to the left.

Figure 6-3-6. Pre-treatment submentovertex radiograph
The mandible can be seen displaced to the left.

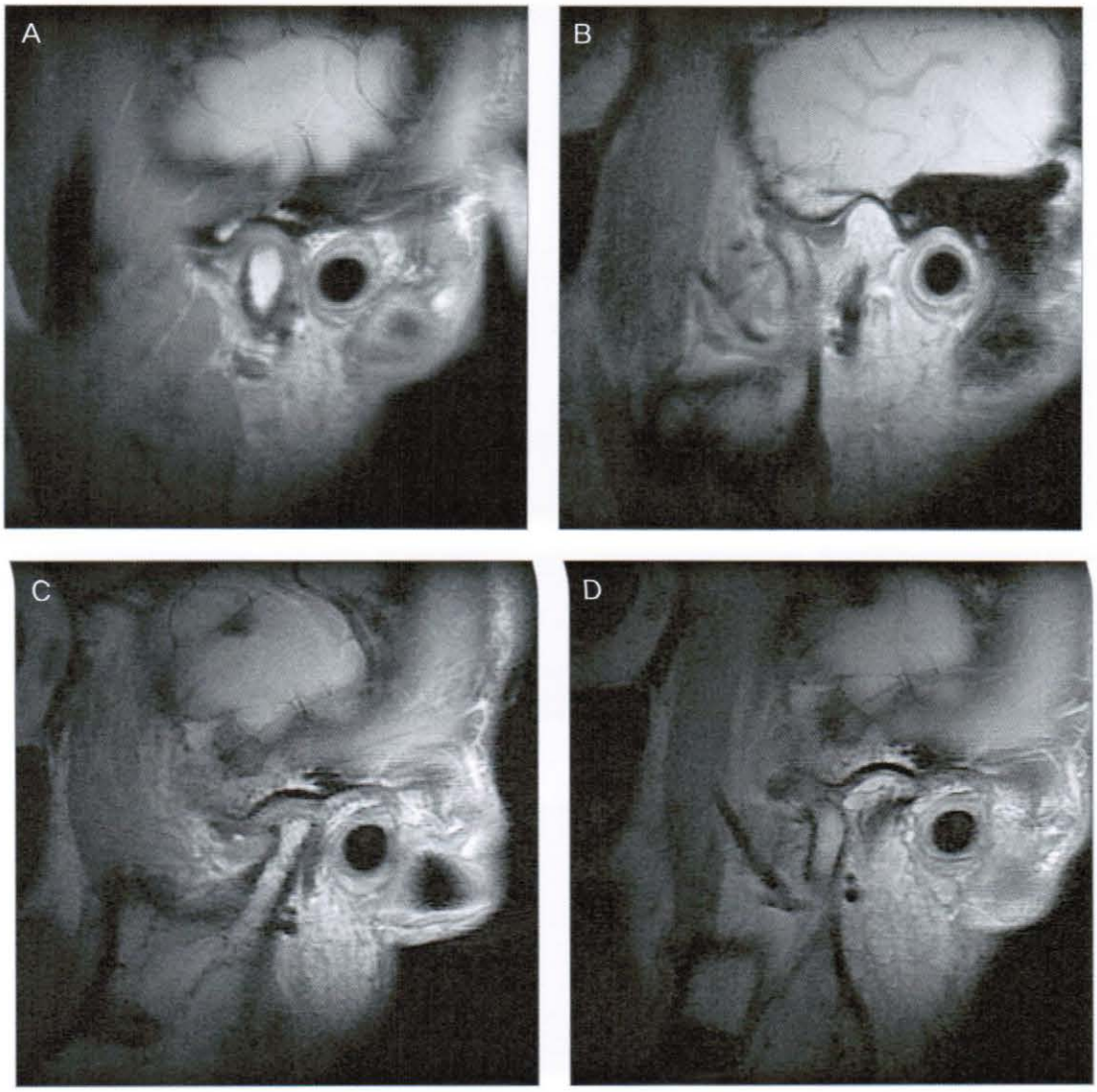


Figure 6-3-9. Pre-treatment MRI of the TMJ
A. Right closed state, B. right maximal open state, C. Left closed state, D. left maximal open state
On MRI there was ADD with reduction on the right side, and ADD without reduction on the left side.

Treatment Progress

- **Implantation & Intrusion of upper central incisors** — 3 months
  - 2005. 8.10 — Bonding on #11 & 21
    1.6×6.0 1EA $\underline{1\downarrow 1}$
    019×025″ ss guide wire + NiTi closed coil spring
- **Intrusion of upper lateral incisors**
  - 2005. 11.8 — Bonding on #12, 13, 22 & 23 014″ NiTi overlay — 2 months
  - 2005. 12.20 — 018″ NiTi overlay
- **Leveling** — 11 months
  - 2006. 1.18 — U : full bonding
    014″ NiTi
  - 2006. 3.15 — 018″ NiTi
  - 2006. 4.5 — L : bonding brackets + 014″ NiTi
  - 2006. 5.24 — 016×022″ NiTi
    L : removable expansion plate (Removal of lower arch wire)
  - 2006. 8.2 — L : 016″ NiTi + open coil from #33 to 43
  - 2006. 9.6 — U : 017×025″ NiTi
    L : 018″ NiTi + open coil from #33 to 43
  - 2006. 10.10 — U : 018×022″ ss with shoe hooks
    L : 018″ ss + open coil from #33 to 43
  - 2006. 12.6 — L : 016×022″ ss with shoe hooks + closed coil from #33 to 43
    Removal of mini-implant
- **Detailing** — 5 months
  - 2006. 12.20 — L : 018×022″ ss with shoe hooks + open coil from #31 to 42
    Stripping of lower incisors
- **Debonding**
  - 2007. 5.11

Total 21 months

While the molar relationship was Class I, this patient showed characteristics of Class II division 2 malocclusion. There is high possibility that if a lower incisor was not missing, the canine and molar relationship would have also been Class II.

The upper central incisors were intruded before intruding the lateral incisors. During this time the lower arch was expanded naturally and spacing occurred between the lower incisors. However because the

lower intercanine width was very narrow, the lower arch was expanded with a removable appliance while the upper dentition was being leveled. After relief of deep bite, bonding of the lower teeth was made possible, and after leveling of the lower arch, space was made for the missing incisor.

Because both arches were crowded before treatment, it can be planned to extract one lower incisor and two upper premolars, but this can be very dangerous. As seen in this case, natural expansion of the lower arch and spacing occurred after relief of deep bite. Also if extraction is performed in deep bite cases, the bite deepens during treatment and treatment becomes difficult to control. Extraction in deep bite patients must be planned with caution.

Because the patient's initial complaint was facial asymmetry, he visited the oral maxillofacial surgeon. However when the deep bite was corrected, the patient decided that he no longer wanted surgery for the asymmetry. As long as the TMJ disorder does not progress, facial asymmetry will not become worse. The patient was very pleased with the result obtained without having performed surgery. He thought that his deep bite could not be treated without surgery. The possibility of genioplasty after treatment was discussed but the patient declined.

Clinical tip ››››

Frequently asked questions regarding deep bite treatment using mini-implants

There is an assertion that using continuous wire will allow upper incisor intrusion and labioversion without much extrusion of molars.

It is true that molar extrusion does not occur frequently in deep bite cases. However without the use of the mini-implant and segmented wire technique, it is nearly impossible to obtain such a large amount of incisor intrusion without any extrusion of the upper molars. If the mandible is retruded in a skeletal Class II pattern, even a small amount of molar extrusion will cause clockwise rotation of the mandible, which is esthetically unfavorable.

Clinical tip ››››

What is the relationship between facial asymmetry and disk displacement?

If disk displacement is present only in one TMJ or one side is worse than the other, in many cases the mandible is deviated to the affected side. Although the causes of TMJ disorder are not clear, it is obvious that TMJ disorder is one factor that causes deformation to the face and dentition.

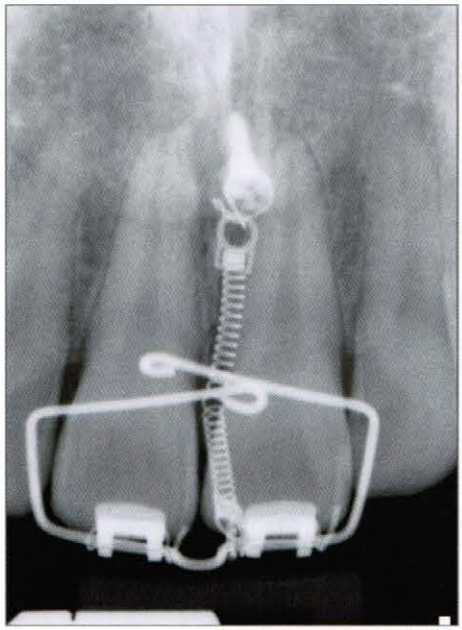


Figure 6-3-10. Periapical radiograph after mini-implant insertion
It has been implanted well between the roots of the central incisors. NiTi closed coil spring is connected.

Clinical tip ››››

Force required for intrusion

A light force has been recommended for intrusion. A force of 15gm per anterior tooth, and 25gm for a molar tooth is appropriate.

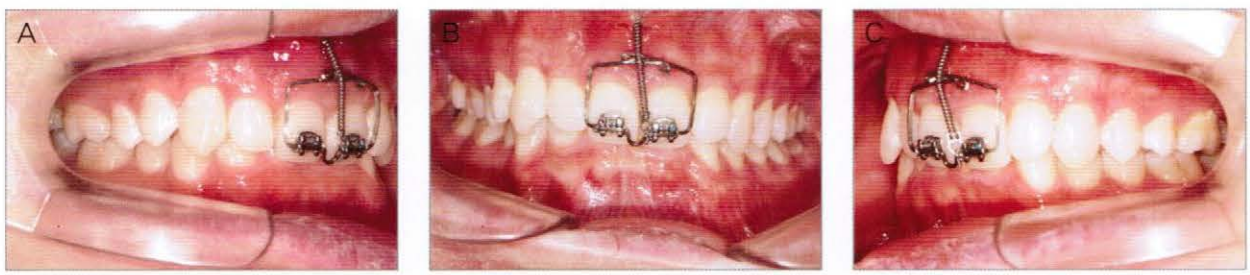


Figure 6-3-11. Intrusion of central incisors (2005. 8.17)
After mini-implant insertion (2005. 8.10), the above appliance was used for intrusion of central incisors. These photographs were taken after stitch out. The guide wire, a 019×025″ wire in a box form, is ligated onto the 2 brackets (022″). A 1.6×6mm mini-implant was implanted without prior drilling. The guide wire prevents the NiTi closed coil spring from impinging on the gingiva. As a result the upper central incisors are intruded with labioversion.

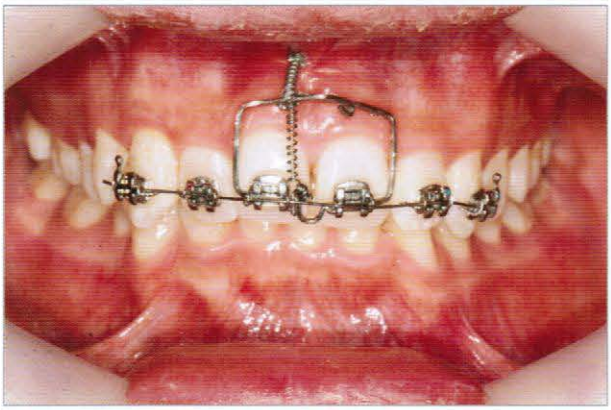


Figure 6-3-12. Three months after intrusion of upper central incisors (2005. 11.8)
After three months, the lower incisors begin to be visible with intrusion of the upper incisors. When the upper central incisors are intruded to the level of the lateral incisors, the lateral incisors and canines are bonded. 014" NiTi is overlaid.

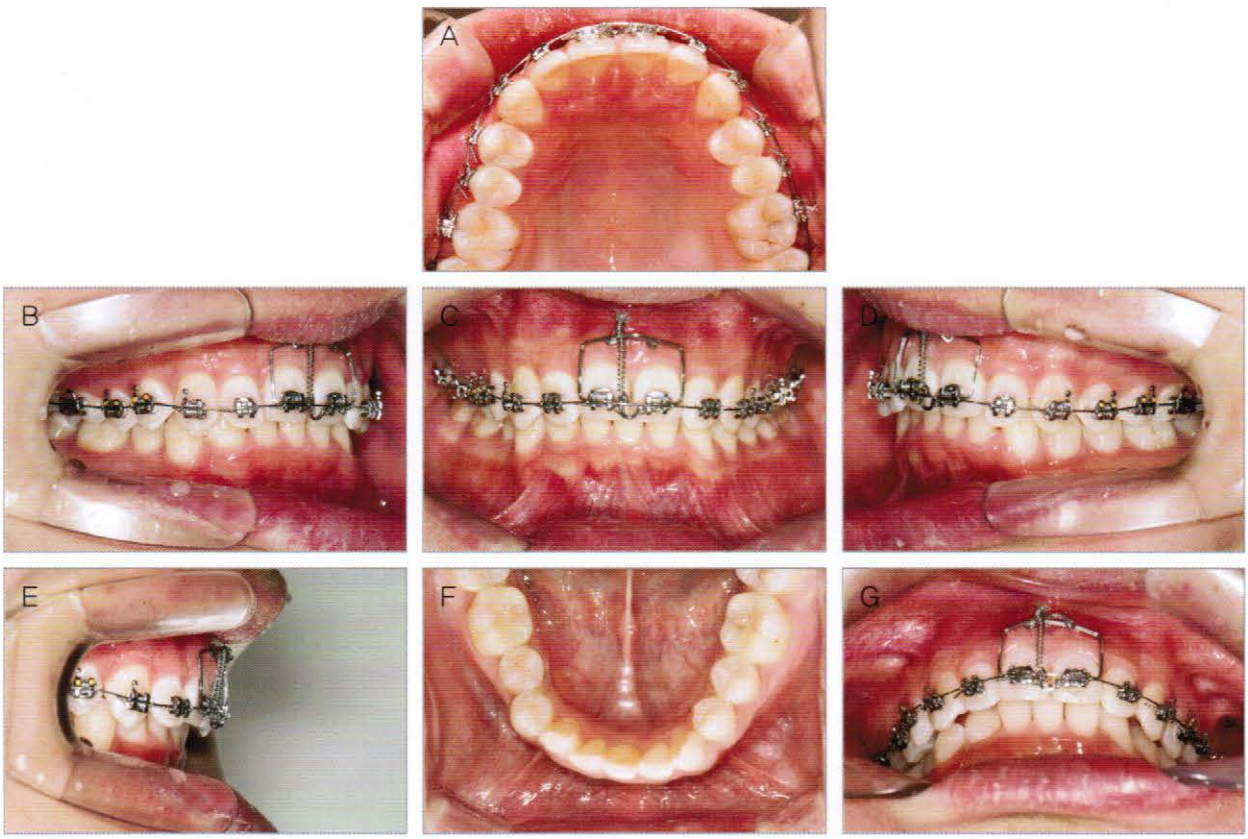


Figure 6-3-13. Five months after intrusion (2006. 1.18)
The entire upper arch is bonded with brackets and 014" NiTi overlaid.

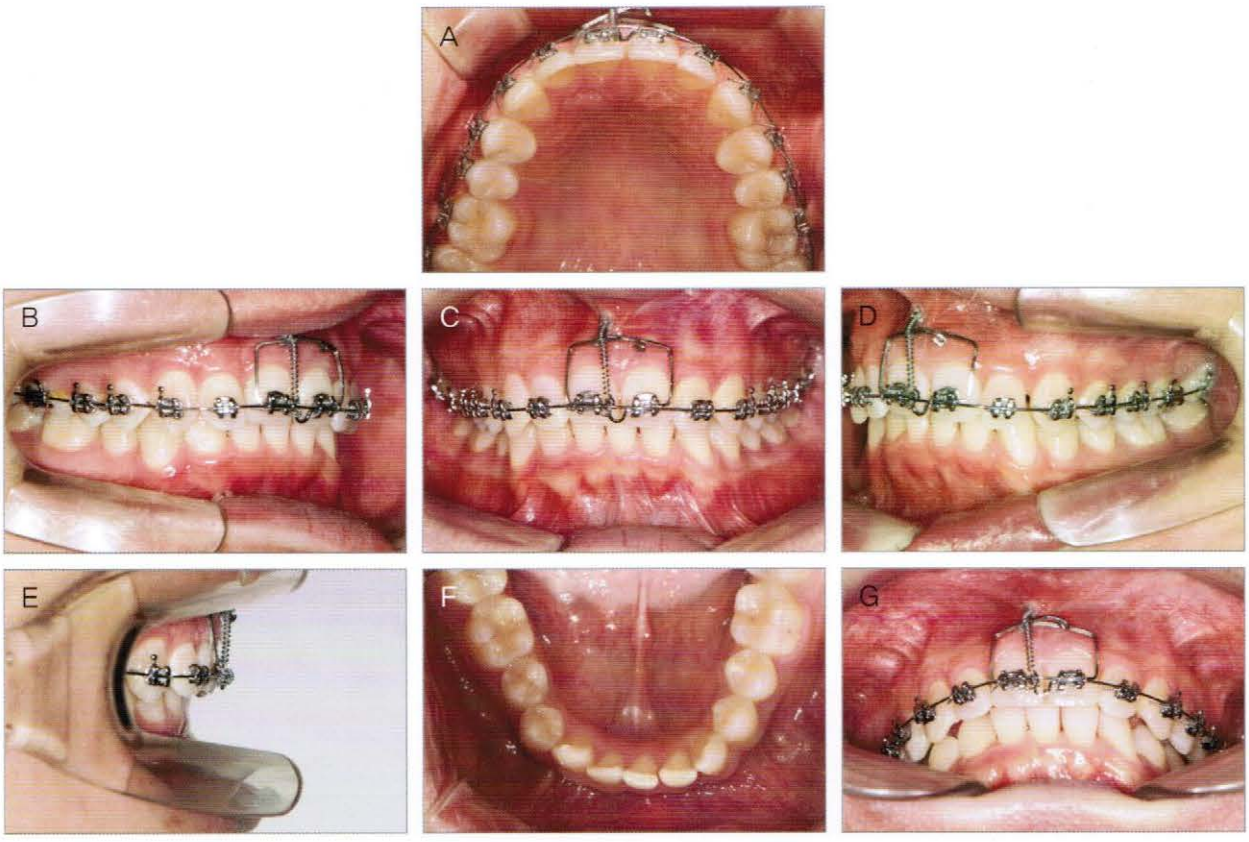


Figure 6-3-14. Eight months after beginning of treatment (2006. 4.5)
This photograph was taken before bonding of the lower arch. The device for upper incisor intrusion has been left in place. It can be seen that a fair amount of upper incisor intrusion has occurred (C). Crowding of the lower arch has been relieved naturally, and spacing has occurred.

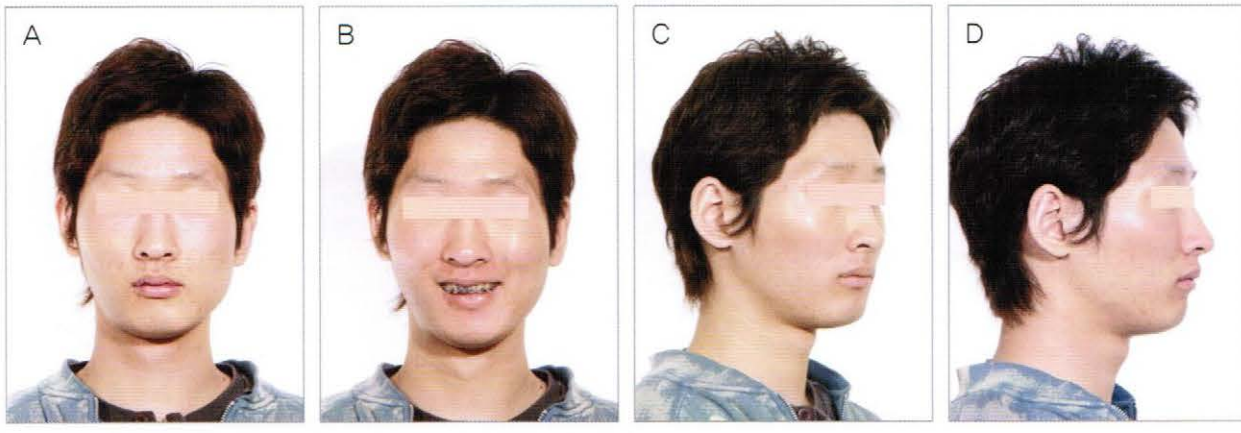


Figure 6-3-15. Eight months after beginning of treatment (2006. 4.5)
Upper incisor exposure during smile has decreased (B). Due to intrusion and labioversion of the upper incisors, the upper and lower lips look protruded (C, D).

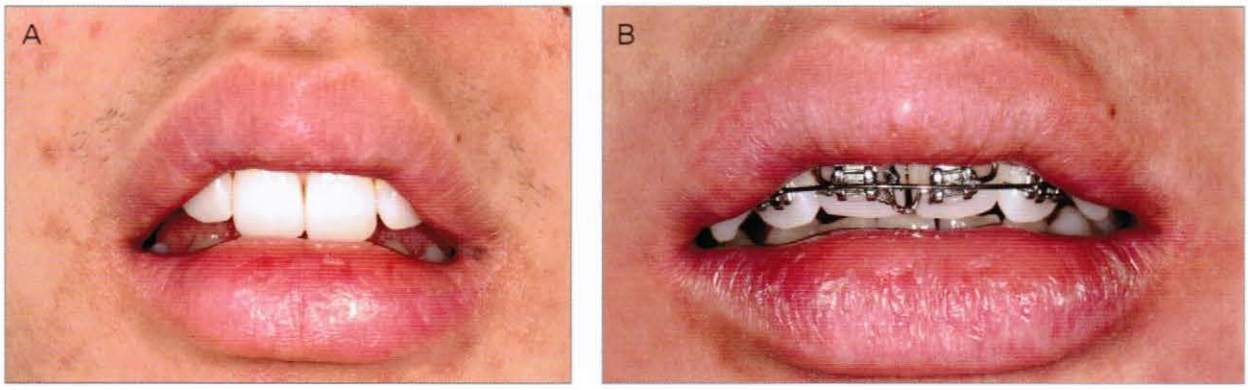


Figure 6-3-16. Comparison of pre-treatment and eight months after treatment (2006. 4.5) at rest
A. Pre-treatment. Because the upper incisal edge could not be seen at rest, it was instructed to open the mouth further.
B. 8 months after intrusion.
Compare the distance between the lower level of the upper lip and incisal edge of the upper incisors. Even without superimposition of cephalometric radiographs, the amount of incisor intrusion can be monitored easily.

Figure 6-3-17. Eight months after upper incisor intrusion (2006. 4.5). Changes in the lower arch.
A. Lower arch pre-treatment.
B. After intrusion of 4 incisors. Even though no appliances were used in the lower arch, expansion of the arch, labioversion of the incisors, and relief of crowding was observed, and spacing occurred between the lower incisors. At this stage, the treatment plan was reviewed. Through non-extraction treatment of both arches, space for the lower right central incisor will be made for prosthodontic treatment.

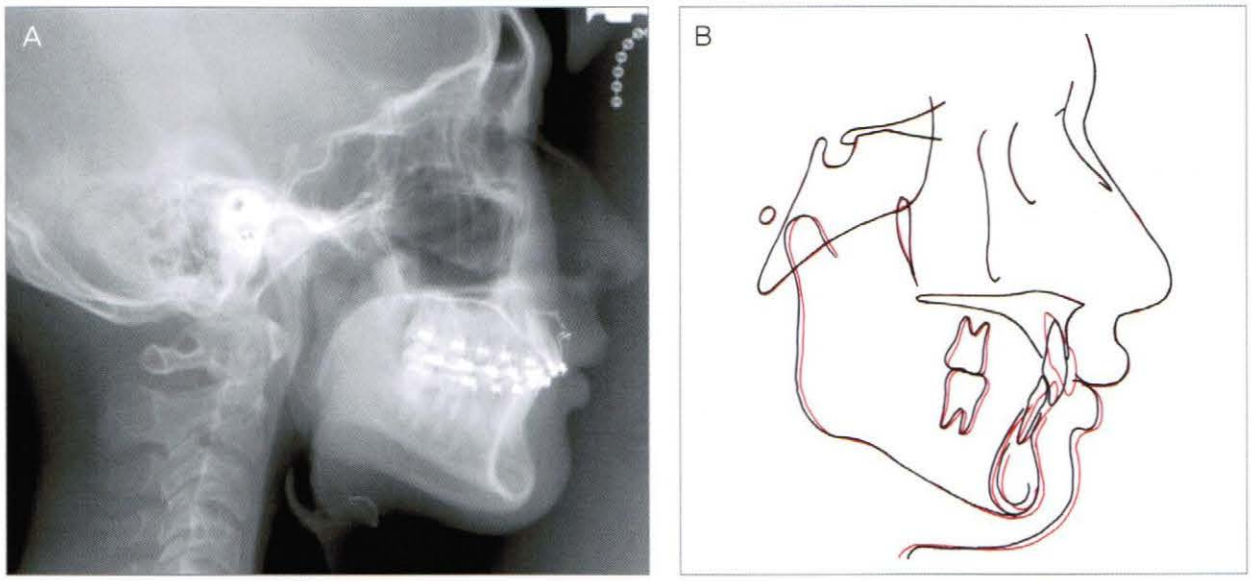


Figure 6-3-18. Eight months after upper incisor intrusion (2006. 4.5), cephalometric radiograph and measurement
A. On cephalometric radiograph, it can be seen that the upper incisors have been intruded and labially inclined.
B. Superimposition of tracing shows that intrusion and labioversion of the upper incisors have occurred. Mouth is protruded. An interesting point is that the lower incisors have become labially inclined without any orthodontic force. The whole mandible is displaced forward (refer to clinical tip).

Clinical tip ››››

Antero-posterior changes of the mandible in adult Class II division 2 deep bite

After treatment of deep bite, it often causes the mandible to be displaced anteriorly. In Dr. Creekmore's case (1983), the mandible was displaced forward after treatment of deep bite as if growth had occurred, even though the patient was fully grown.

As a result, the chin moves forward and helps to improve the retruded facial profile. Especially in case 10, Class II elastics were not used because the patient had a Class I molar relationship.

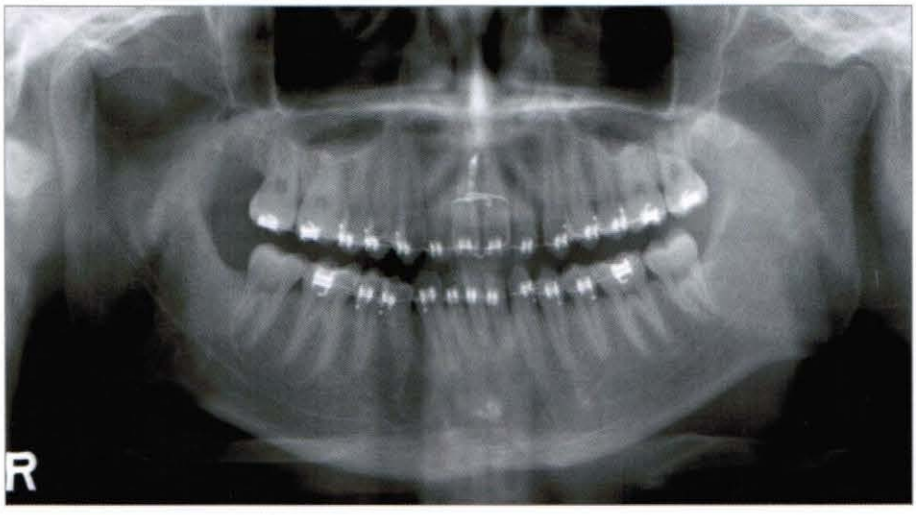


Figure 6-3-19. Panoramic radiograph eight months after intrusion of the central incisors (2006. 4.5) No abnormalities such as root resorption are observed.

After examining the mid-treatment data (Figure 6-3-14~19), the treatment plan was re-examined. Although facial asymmetry still remains, the patient asked that treatment be completed without orthognathic surgery. The lower intercanine width was narrower than that of the maxillary arch. With the lower archwire removed, expansion of the lower arch was planned using a removable appliance. Expansion was carried out for 10 weeks. Screw was turned 1/4 turn 2 times a week.

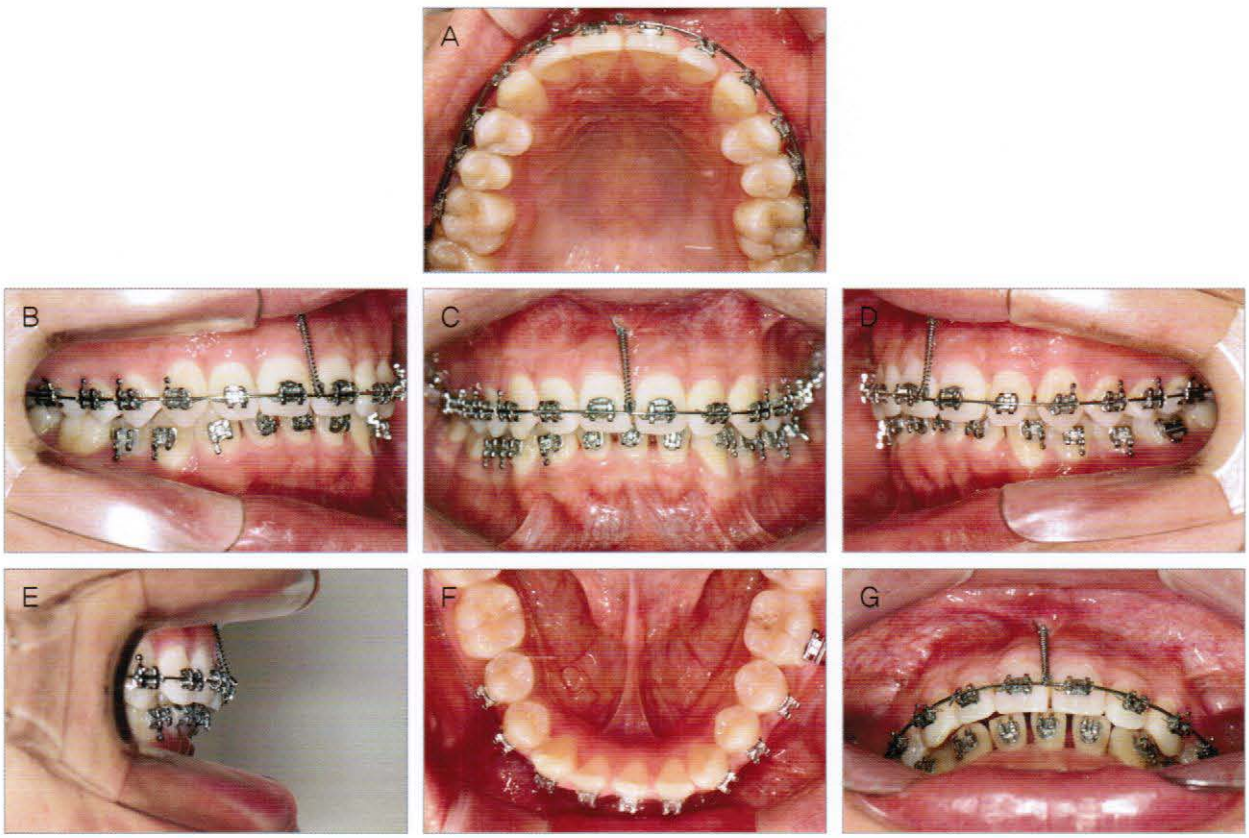


Figure 6-3-20. Intraoral photograph 6 weeks after expansion using a removable appliance (2006. 7.5)
The lower archwire has been removed for insertion of the removable appliance. Spacing in the lower incisor region has increased. The guide wire used in the upper central incisors has been removed (C). This is because there is no longer impingement of the gingiva.

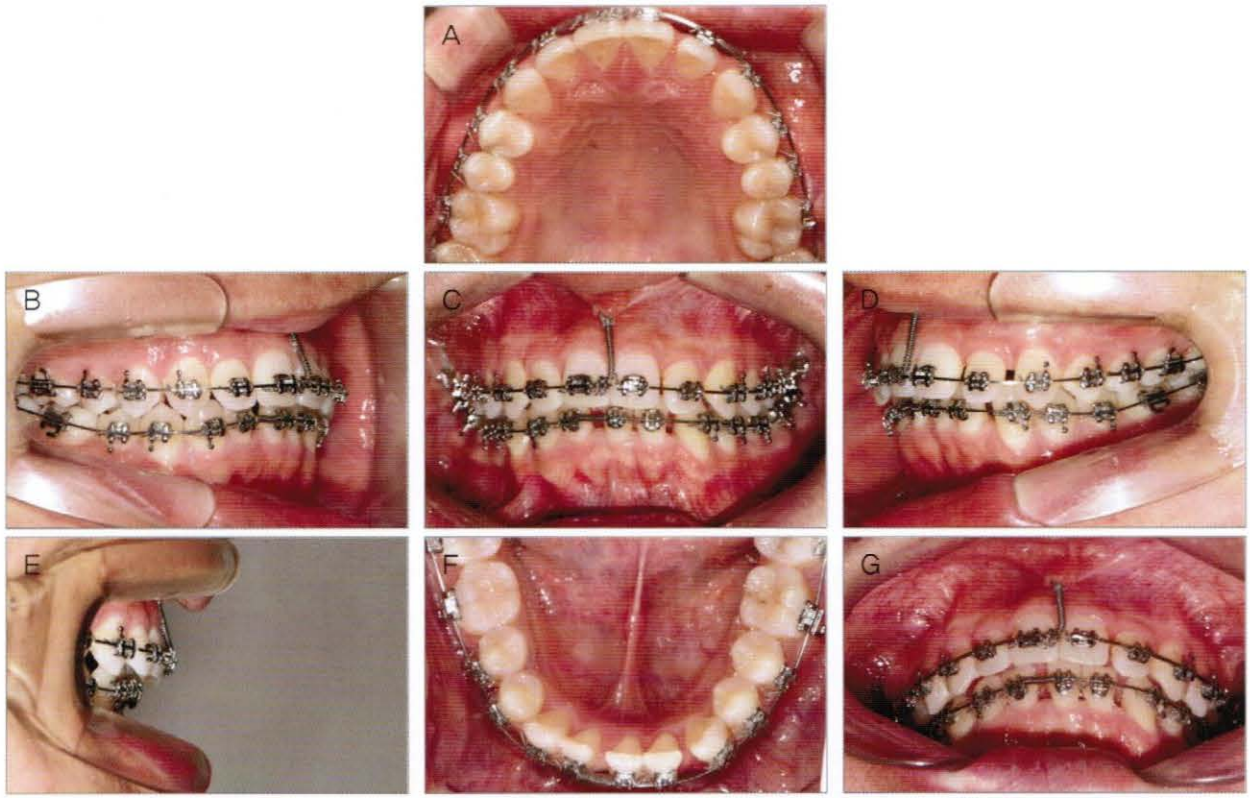


Figure 6-3-21. Leveling of the lower dentition and space regaining for tooth #41 (2006. 9.6)
017×025″ NiTi in the upper arch and 018″ NiTi with open coil has been inserted. The open coil is inserted between the lower left central incisor and the right lateral incisor (C, F).

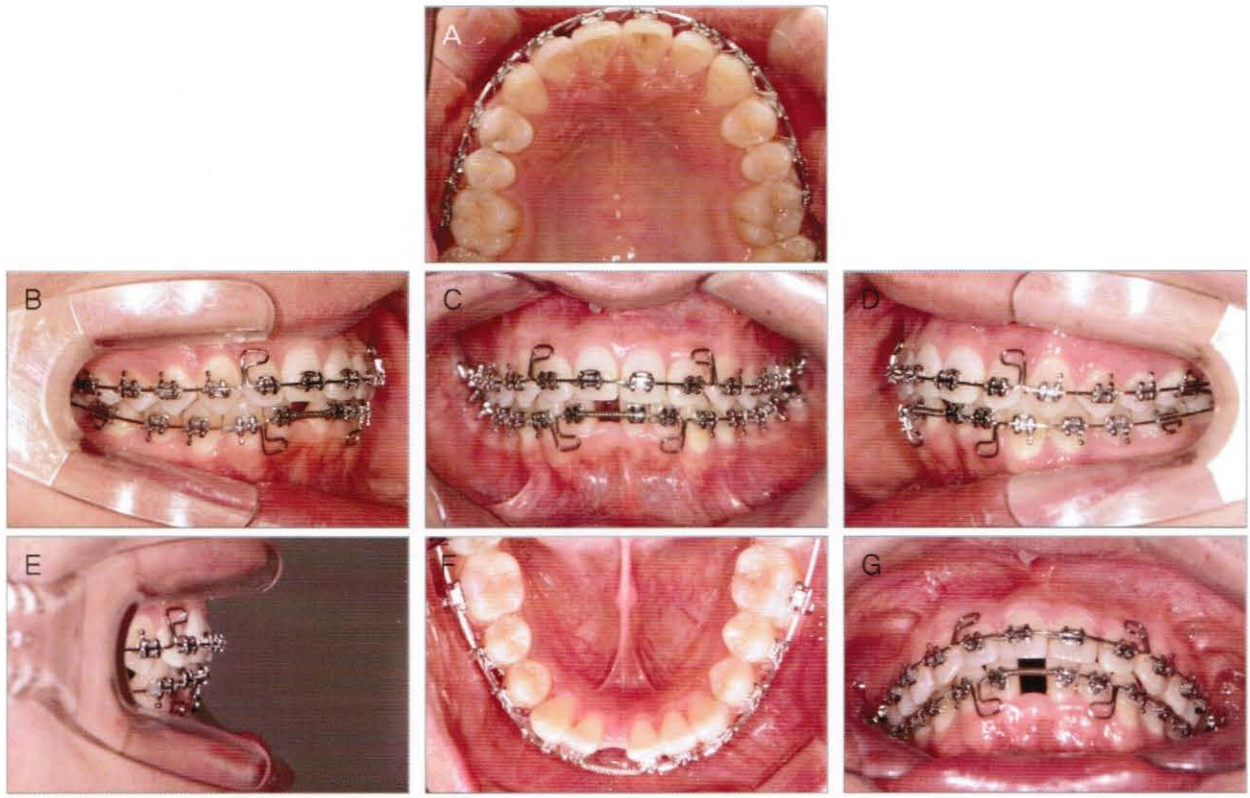


Figure 6-3-22. Detailing stage (2006. 12.20)
Mini-implant was removed after ligation of 018×022″ ss with shoe hooks in the upper arch. 018×022″ ss with shoe hooks and open coil has also been inserted in the lower arch. The patient was referred for the #41 implant at this stage.

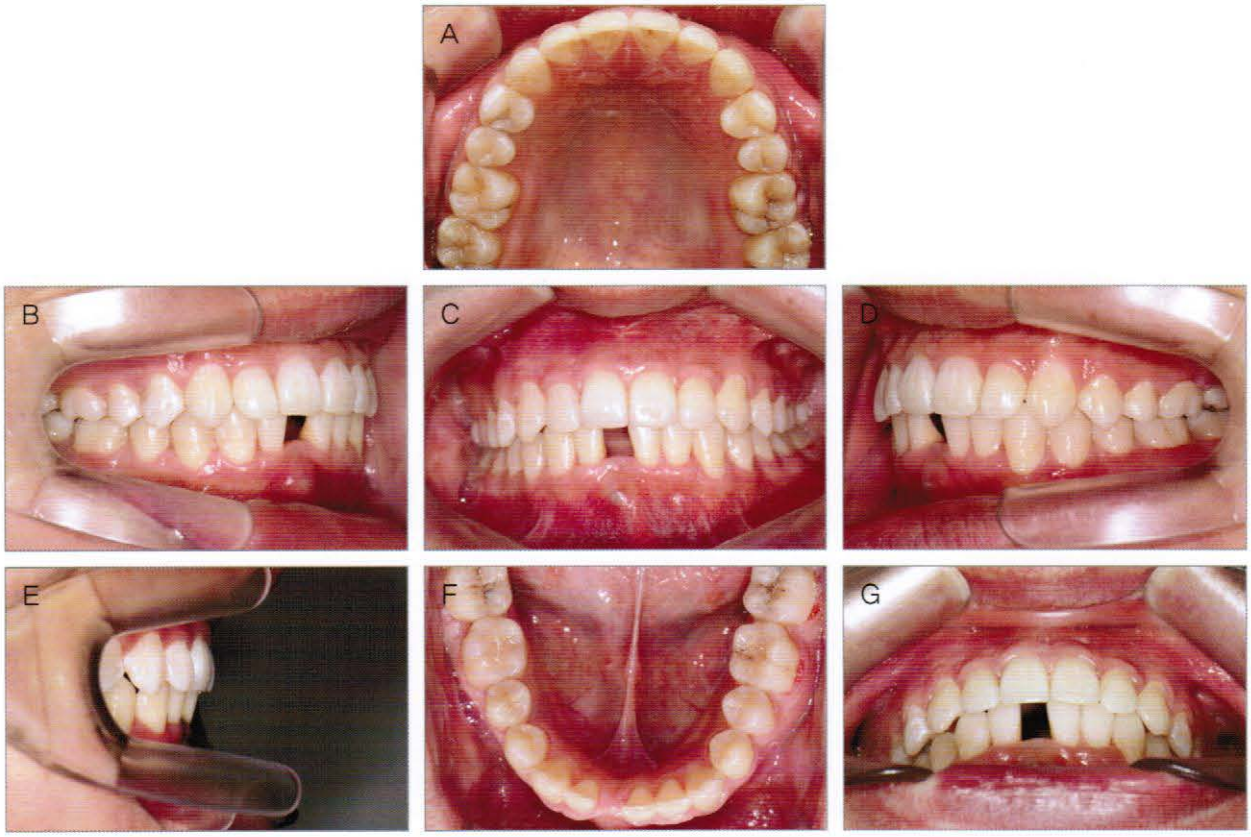


Figure 6-3-23. Intraoral photograph at debonding (2006. 5.11)
Good occlusion was achived in 21 months. Space for tooth #41 has been regained (C). The screw seen beneath the gingiva of the #41 tooth space has been placed after bone grafting to keep the graft stable.

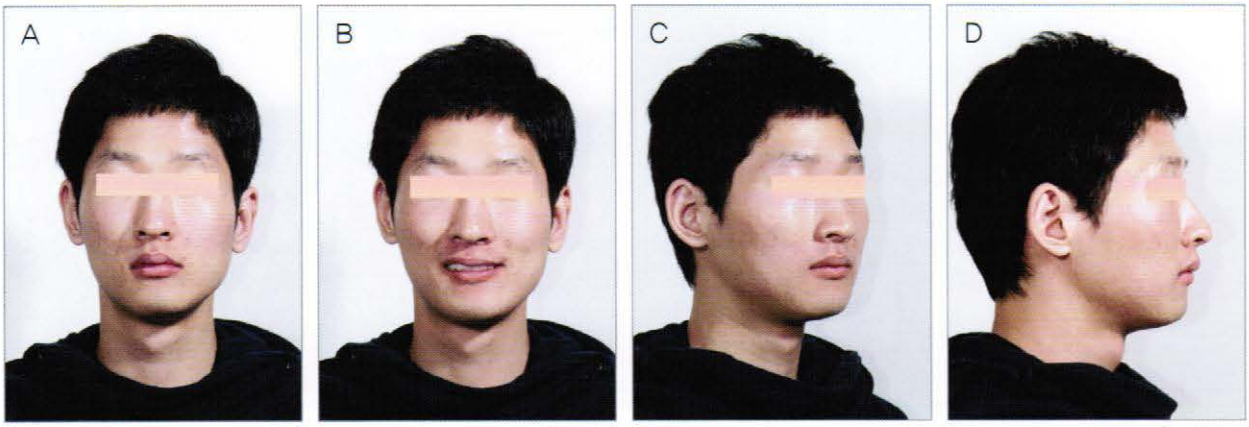
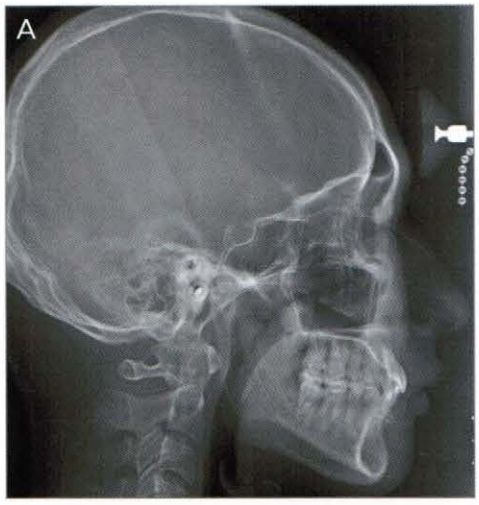
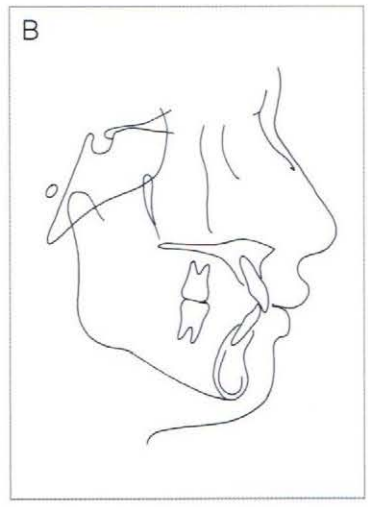
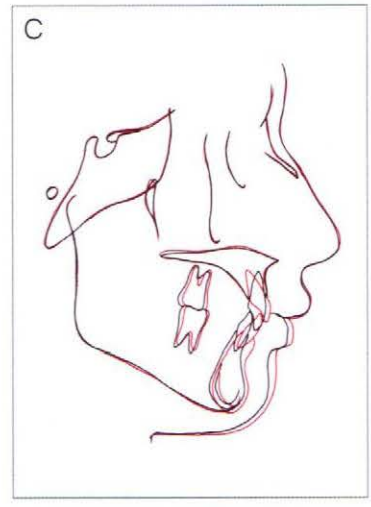
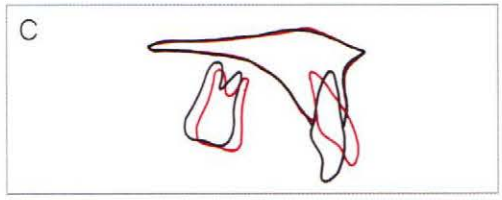


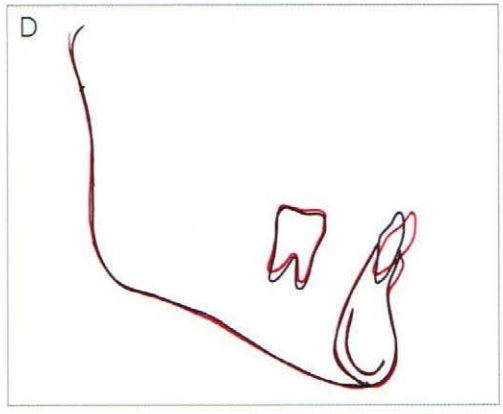
Figure 6-3-24. Facial photographs at debonding (2006. 5.11)
His profile has been much improved compared to pre-treatment (D).











F

	Norm	SD	T1	T2
SNA	82.5	3.2	78.2	77.4
SNB	80.4	3.1	73.0	73.6
ANB	2.1	1.7	5.2	3.8
FMA	22.7	5.3	24.4	25.7
ODI	73.3	5.9	84.3	80.5
U1 to FH	116.3	5.6	87.8	108.6
IMPA	96.6	6.6	85.8	98.0
IIA	124.4	8.0	162.1	127.7
Esth-U	-0.7	2.2	-0.1	2.9
Esth-L	0.5	2.3	-2.4	-0.3

Figure 6-3-25. Cephalometric radiograph and measurement at debonding
A. Post-treatment cephalometric radiograph
B. Tracing
C. Pre- and post-treatment superimposition of tracing. Good profile has been achieved with forward movement of the mandible.
D. There has been intrusion and labioversion of the upper central incisors.
E. Lower first molar and central incisor have been extruded slightly and labially inclined.
F. T1 is pre-treatment, T2 is at debonding. With a decrease in interincisal angle from 162.1° to 127.7°, it is now in the normal range.

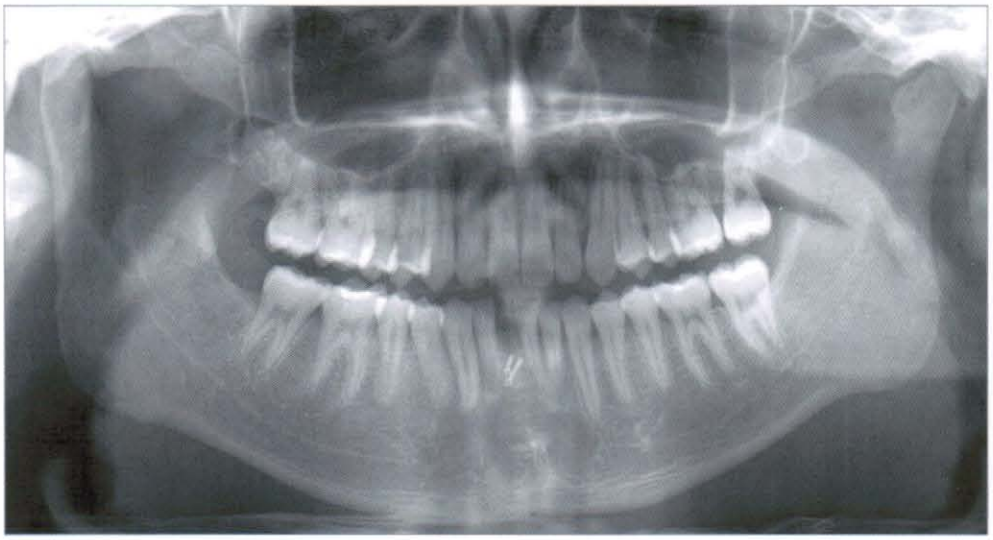


Figure 6-3-26. Panoramic radiograph at debonding
There is no root resorption. Screw has been inserted for bone grafting in the region of tooth #41.

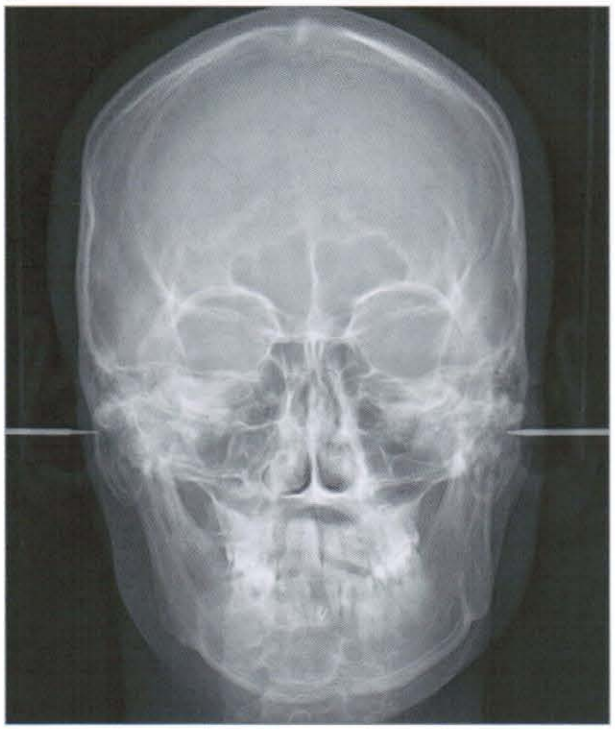


Figure 6-3-27. Postero-anterior radiograph. The asymmetry still remains, but the patient was happy with his dentition after orthodontic treatment and no longer complained of asymmetry.

References

1. Creekmore TM, Eklund MK. The possibility of skeletal anchorage. J Clin Orthod 1983;17:266-9.

Ⅲ. Intrusion of labially tipped incisors

Even if the bite is not deep, there are cases where upper incisors must be intruded to correct gummy smile. If the upper incisors show labioversion and protrusion, retraction must be carried out at the same time. In normal circumstances, if the case is treated with mechanics used in Case 1 and Case 2 of Chapter 3, gummy smile and protrusion will be corrected together. However, some patients have open bite skeletal characteristics and in these cases, upper molar intrusion must be carried out more actively. Case 11 is a good example. Firstly the upper molars must be intruded for the gummy smile to be relieved.

For a detailed explanation on gummy smile, please refer to the series of 5 articles entitled 'Treatment of gummy smile using mini-implants' contained in the Korean Journal of Clinical Orthodontics (Myung mun publishing) in the May, July, September, November 2007 and January 2008 issues.

■ Case 11 (Figure 6-4-1 to 23)

- Age : 19 years 2 months
- Sex : female
- Chief complaint : gummy smile, mouth protrusion

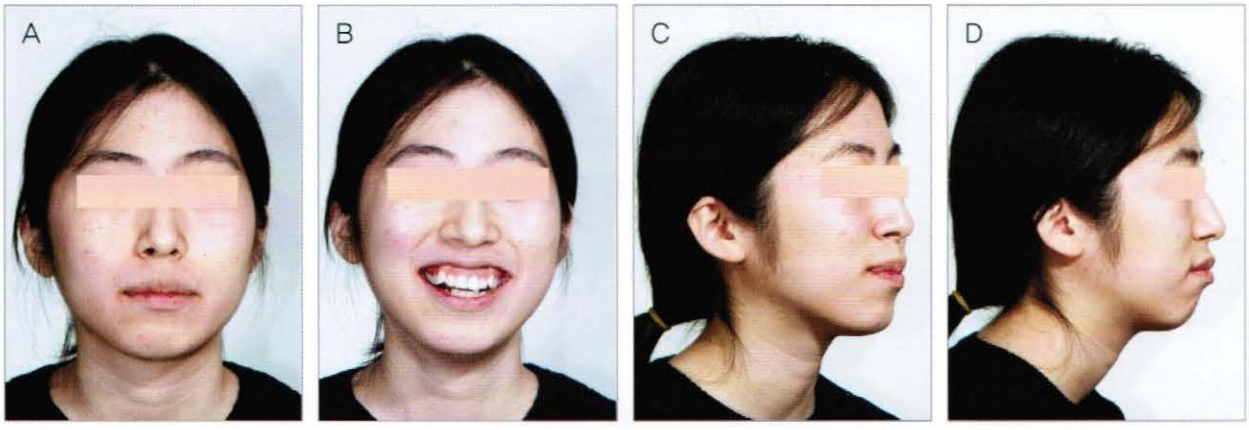


Figure 6-4-1. Pre-treatment facial photographs of Case 11
The patient's chief complaints were excessive exposure of gingiva on smile and mouth protrusion. The patient tenses her mouth habitually during mouth closure. It would seem that the habit has formed to be able to close the lips over the protruded teeth and overexposed gingiva.

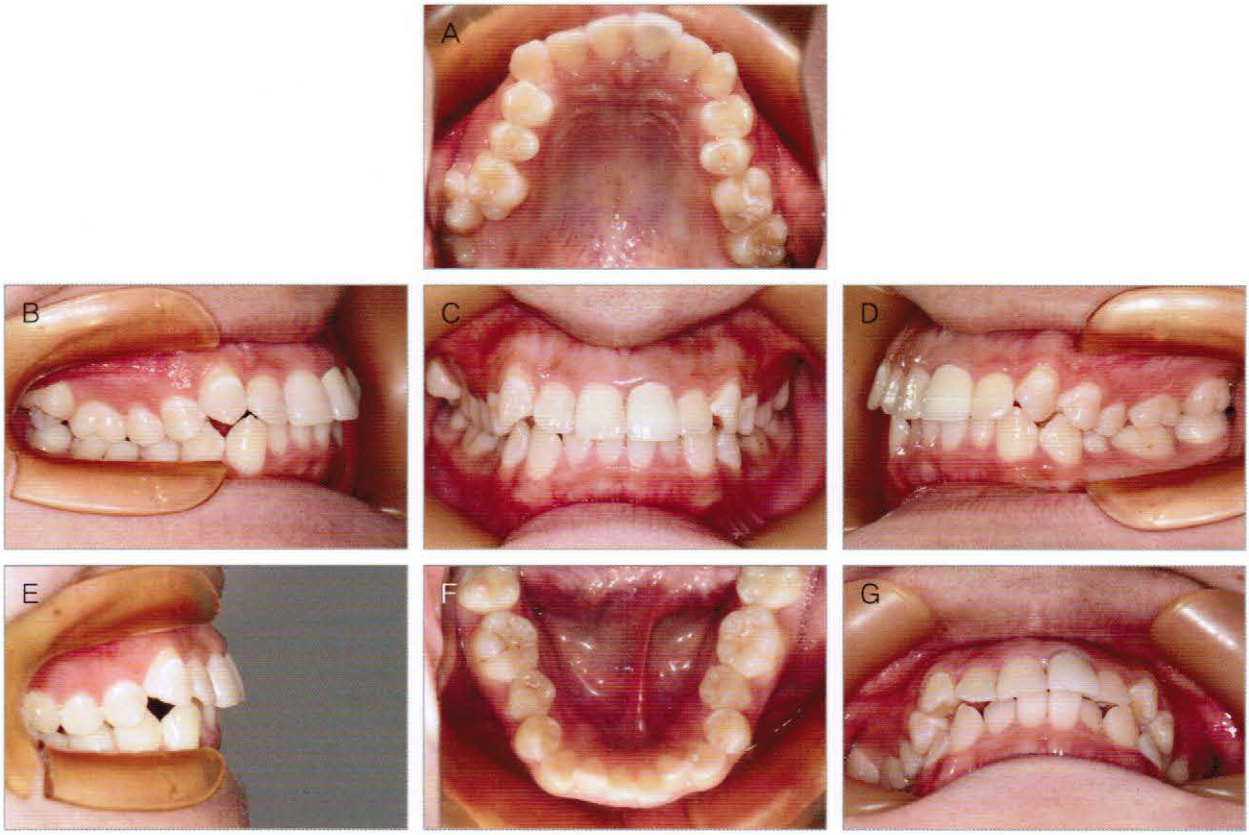


Figure 6-4-2. Pre-treatment intraoral photograph of Case 11
There is crowding in both arches (A, F). The upper right second molar is in scissor bite (B). The canine and molars show a Class II tendency (B, D). Because the upper molars are extruded, a curve can be seen (B, D). Curve of Spee is severe (B, D). The upper left central incisor has a PfM crown (C).

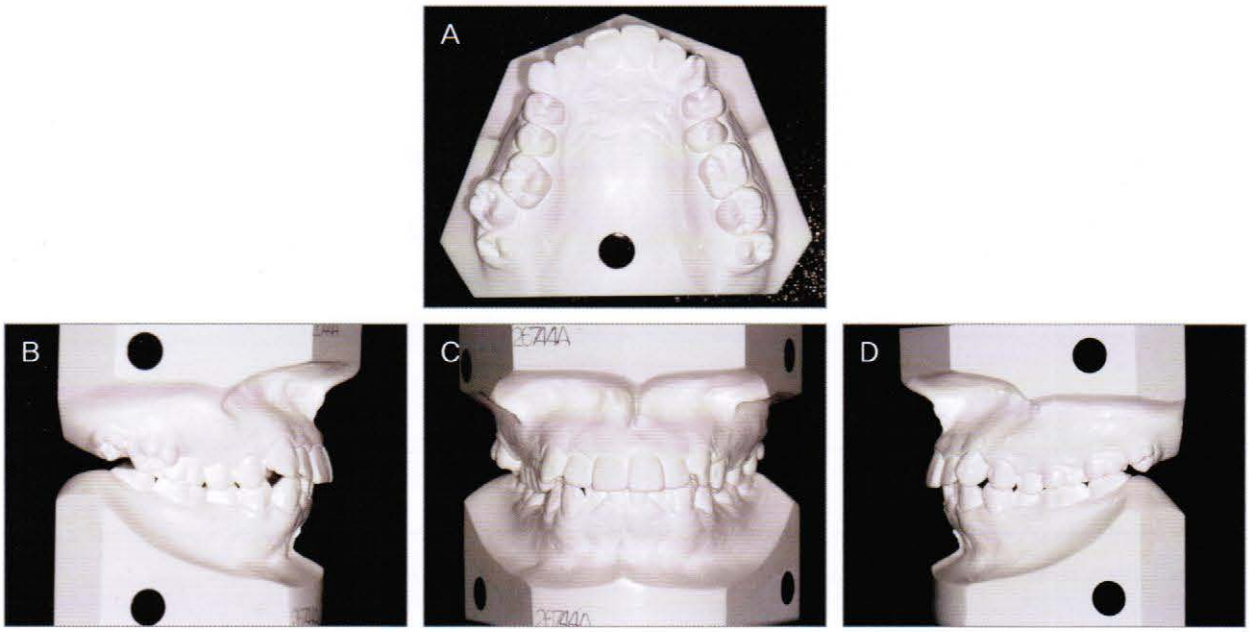
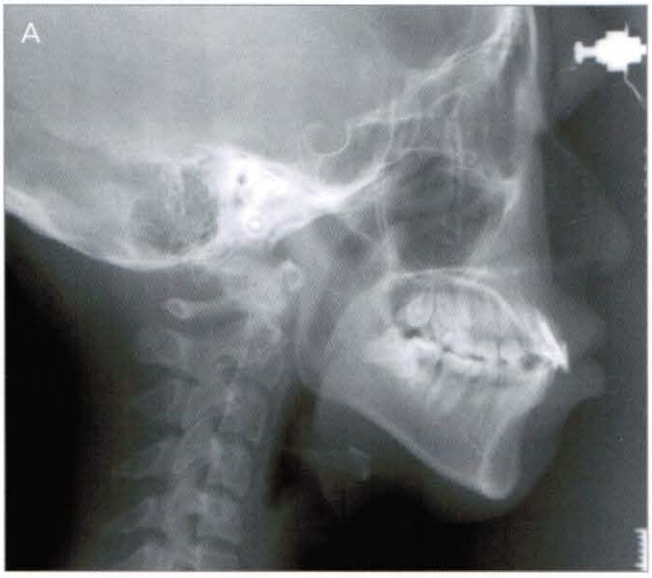
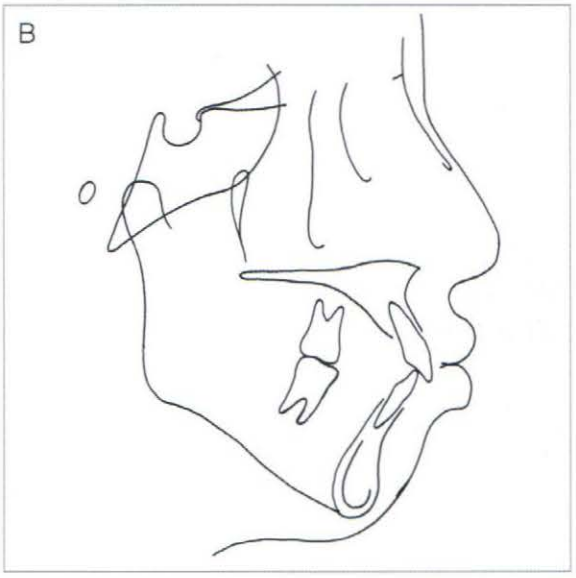


Figure 6-4-3. Pre-treatment model of Case 11
Although on intraoral radiograph it seems the molars are in a Class I relationship, the model shows that it is actually Class II.





C

	Norm	SD	T1
SNA	81.6	3.2	75.6
SNB	79.2	3.0	71.3
ANB	2.5	1.8	4.4
FMA	24.3	4.6	31.1
ODI	72.2	5.5	67.6
U1 to FH	116.0	5.8	115.5
IMPA	95.9	6.4	93.0
IIA	123.8	8.3	120.4
Esth-U	-0.9	2.2	4.4
Esth-L	0.6	2.3	8.1

Figure 6-4-4. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C)
A. The mandible is retruded compared to the maxilla.
B, C. The antero-posterior relationship can be said to be Class II. She has a slight open bite skeletal pattern.

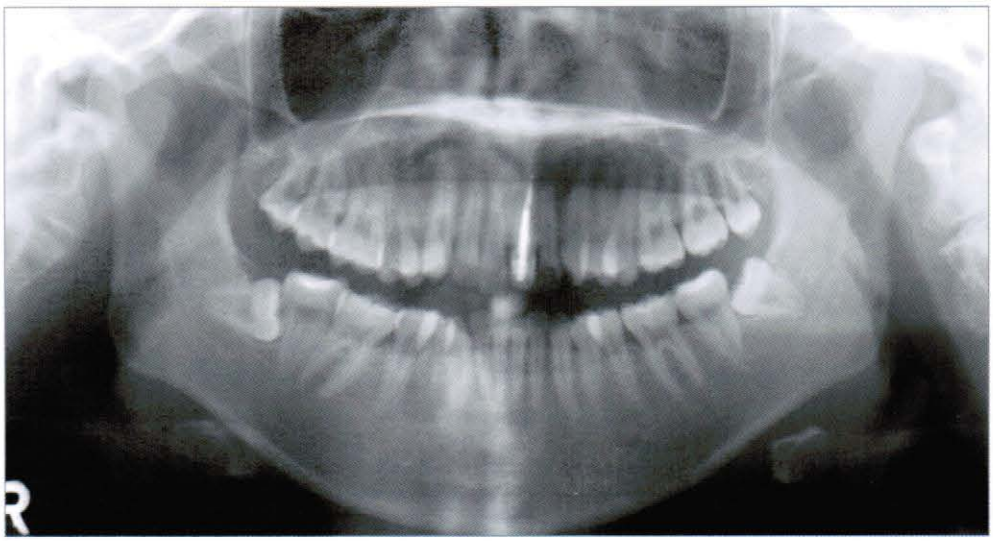


Figure 6-4-5. Pre-treatment panoramic radiograph
All the 3rd molars are present.

Figure 6-4-6. Pre-treatment postero-anterior radiograph
No asymmetry is seen.

Treatment Progress

▪ Segmental leveling — 4 months

- 2004. 1.7 — 014″ NiTi (except if #17)
- 2004. 2.4 — 018″ NiTi
- 2004. 3.23 — Implantation 1.6×6.0 1EA midpalatal
- 2004. 3.24 — TPA with hooks for alignment of #17
- 2004. 4.7 — 016×022″ NiTi
- 2004. 4.28 — 018×025″ NiTi

▪ Segmental Intrusion of upper posterior teeth — 5 months

- 2004. 5.12 ~ 10.22 — TPA with hooks for intrusion of upper posterior teeth
  016×022″ NiTi (#15 ~17)

▪ Continuous leveling

- 2004. 7.28 — U : 014″ NiTi
  L : 018″ NiTi
- 2004. 8.25 — U : 016″ NiTi
  L : 016×022″ NiTi
- 2004. 9.8 — U : 016×022″ NiTi
  L : 016×022″ ss
- 2004. 10.22 — Removal of midpalatal implant and TPA

▪ Space closing — 6 months

- 2004. 10.27 — Implantation 1.6×6.0 2EA $\underline{7\downarrow 6|6\downarrow 7}$
- 2004. 11.10 — U : 019×025″ ss with long hooks
  L : 018×022″ ss with shoe hooks

▪ Detailing — 4 months

- 2005. 4.12 — U : 019×025″ ss with shoe hooks (crown labial torque)

▪ Debonding

- 2005. 8.10

Total 19 months

This case has a Class II skeletal open bite pattern. First premolars and third molars were all extracted. First, TPA was used to correct the upper right second molar scissorbite (a hook was soldered onto the TPA) (Figure 6-4-9A). With the exception of this tooth, the rest of the arch was leveled segmentally.

A 1.6x6.0mm mini-implant was inserted in the midpalatal area, and an extra hook was soldered onto the TPA for intrusion of the second premolar and second molar.

When the level of the posterior teeth became level with the anterior teeth, leveling was continued using continuous archwire.

After leveling, 1.6x6.0mm mini-implants were implanted between the upper first and second molars for retraction of the incisor teeth, and relief of mouth protrusion.

Clinical tip ››››

Reasons for segmental leveling in the upper arch

The upper arch showed excessive curvature due to overeruption of molars. If a continuous archwire is used from the beginning, it causes unwanted extrusion of the incisors, and these occlusal interferences will cause the mandible to be rotated backwards in a clockwise direction. This will worsen the Class II relationship which has unfavorable esthetic results due to retrusion of the tip of the chin.

The patient's chief complaint was gummy smile. Therefore use of continuous archwire was avoided to stop any unwanted extrusion of upper incisors. The upper molars were intruded first, and when the level of the molars and incisors were coincident, leveling through continuous archwire continued.

Clinical tip ››››

Clinical implications of upper second molar scissor bite

1) It means that there is lack of space in the back of the maxilla.
   Extraction of the upper third molar is needed. Or extract the second molar and use the third molar as an alternative. This is also called 'Posterior crowding'.
2) This must be treated early during treatment.
3) Transient open bite may occur during treatment.
   When the buccally tilted molar is forced in, it rotates with the center of rotation at the bifurcation area, and causes the palatal cusp drop down (Figure 6-4-7B). This acts as a wedge in the posterior area and causes open bite. For prevention, TPA with hooks and mid-palatal mini-implant can be used. When the upper right second molar is being retracted toward the palate, the force vector is changed so that an intrusive force is given simultaneously. If it extrudes as a side effect, power chain can be placed between the mini-implant and right second molar to prevent extrusion (Figure 6-4-8).

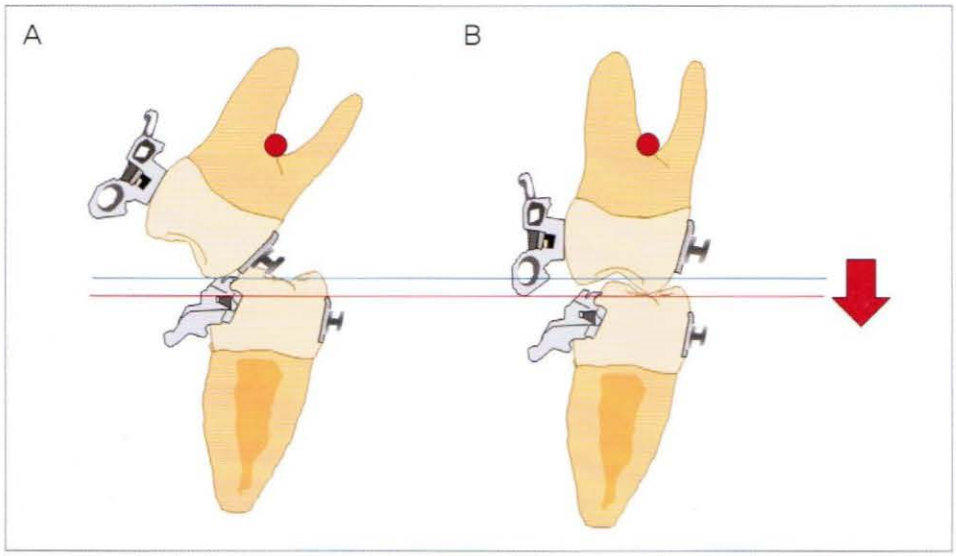


Figure 6-4-7. Side effects of upper second molar scissor bite correction
A. Illustration of upper right second molar scissor bite in Case 11
B. When the buccally tilted molar is forced in towards the palate, it rotates around the center of rotation placed at the bifurcation area and the palatal cusp drops down. This acts as a wedge to cause open bite. Refer to 'clinical tip'.

Method 5

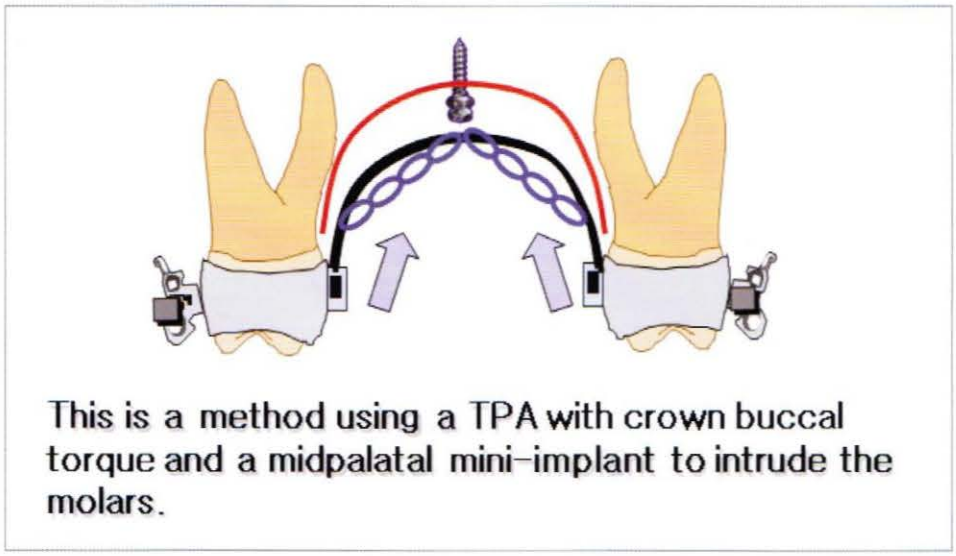


Figure 6-4-8. Diagram of upper molar intrusion mechanics
A thick wire is inserted in the brackets (022") to minimize play. This will allow the upper second premolar and second molar to be intruded together. If needed, TPA with hook is soldered as shown in Figure 6-4-8A to allow intrusion of the second molar. Refer to the Method 5 in Chapter 5 (Molar intrusion). TPA is expanded slightly, with a crown buccal torque of around 5°.

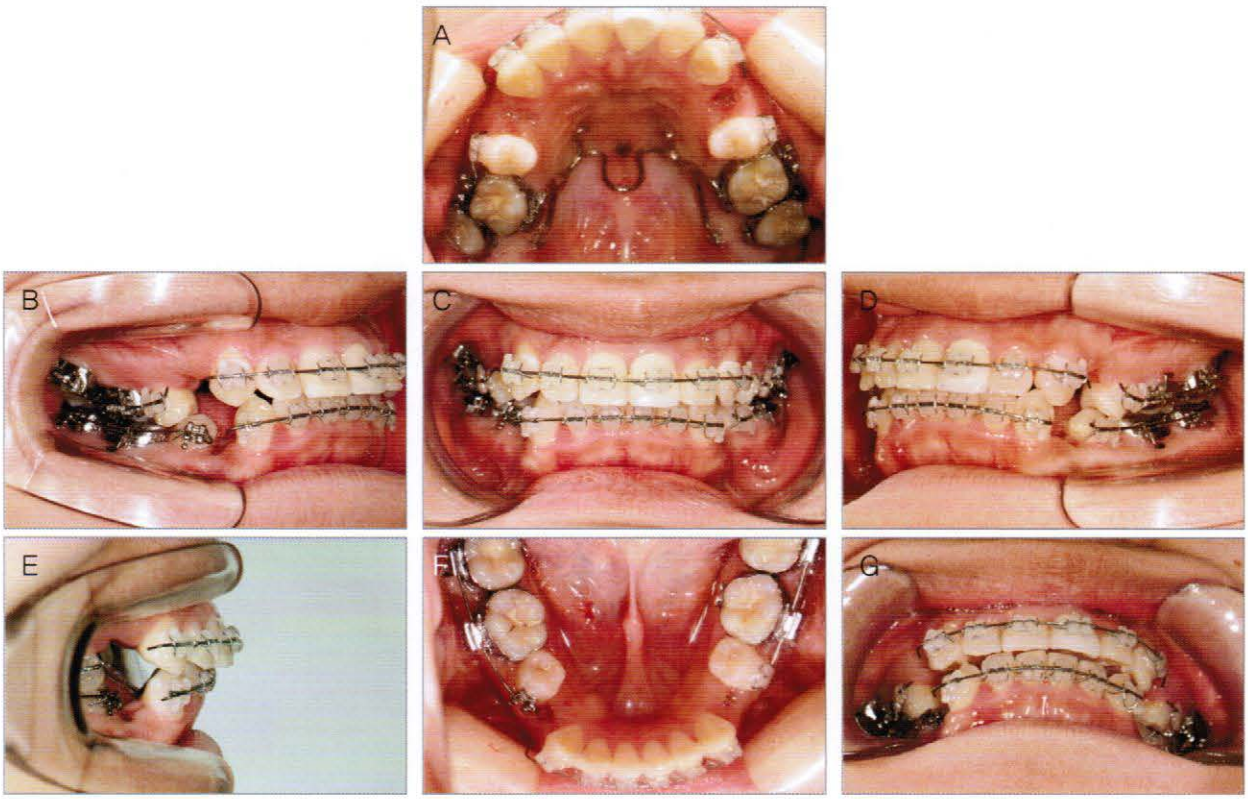


Figure 6-4-9. Palatal traction of upper right second molar (2004. 3.24)
A TPA has been inserted in the maxilla. Power chain is hooked on to a hook soldered on the TPA for traction of the upper second molar palatally. The force vector is adjusted so that an intrusive force is given. A 1.6×6.0mm mini-implant has been implanted in the mid-palate. To prevent the reactionary extrusion of the upper right second molar, power chain was placed between the mini-implant head and the TPA. Archwire has not been ligated to the upper right second molar (B). The rest of the dentition was leveled using segmental wires.

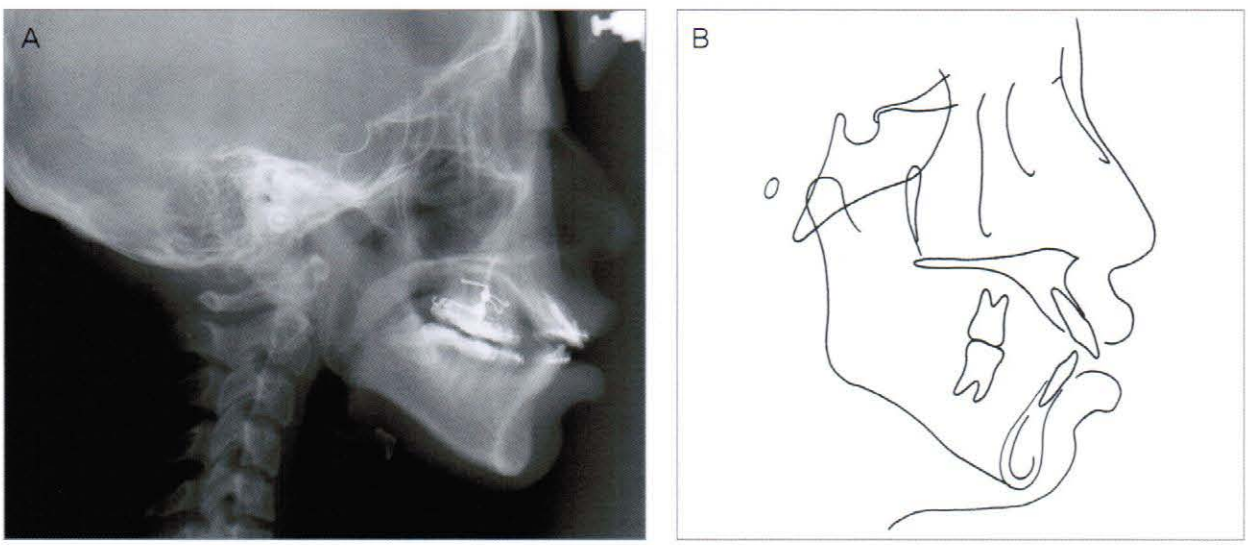


Figure 6-4-10. Cephalometric radiograph (A) and tracing before intrusion of the upper right second molar (2004. 3.24)
The radiograph was taken to compare the intrusion effects. The mid-palatal mini-implant can be seen (A). This mini-implant can be used as a fixed reference point for superimposition after treatment. It can be seen that mouth closure is difficult without forcing the lips together. Proper intrusion of the upper molars was begun after resolving the upper right second molar scissor bite, and 016×022″ NiTi was inserted (2004. 5.12). Intrusion was carried out for 5 months. Continuous archwire was used only after the molars were intruded to the same level as the incisors (2004. 7.28).

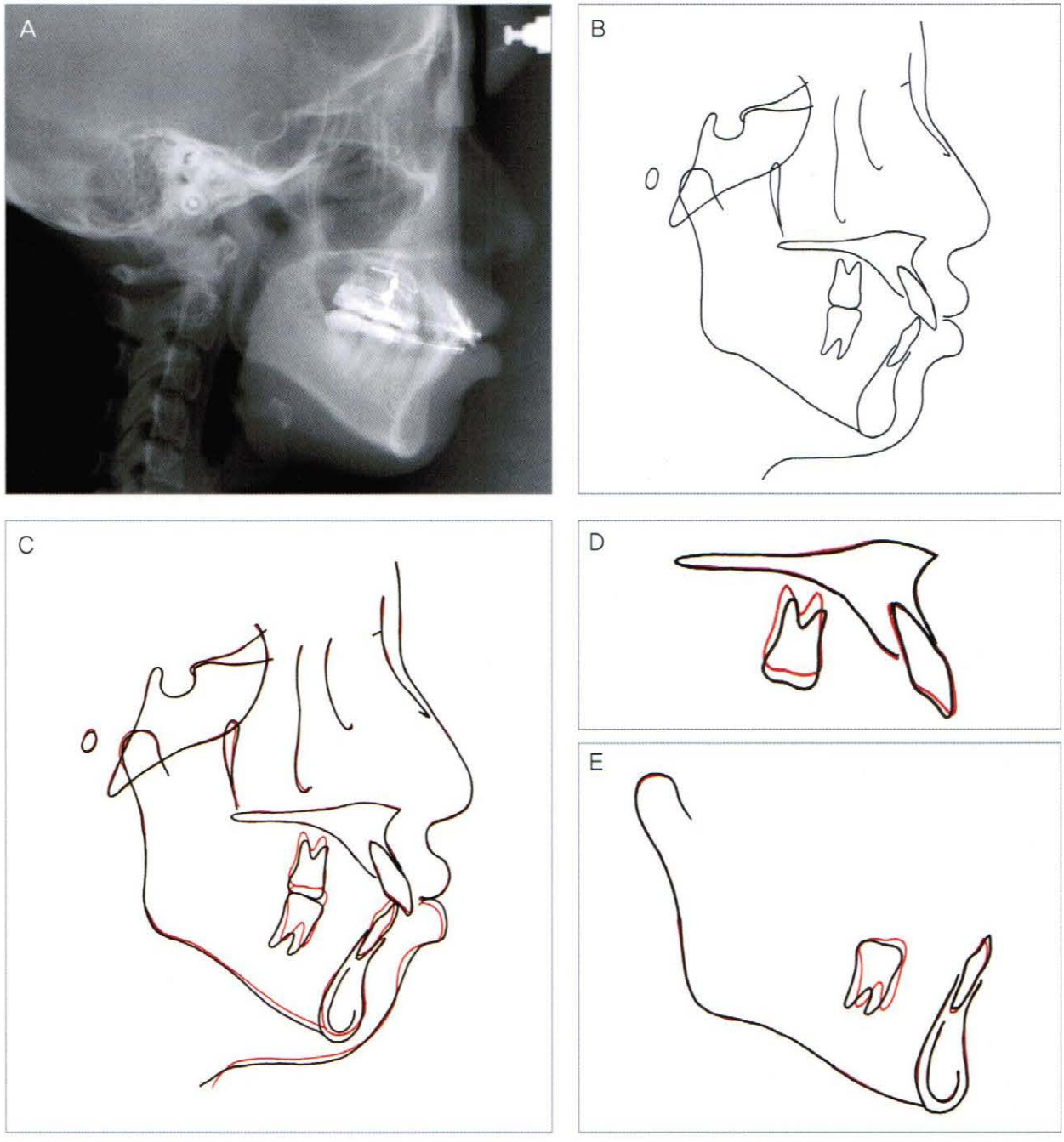


Figure 6-4-11. Cephalometric radiograph and measurement after upper molar intrusion (2004. 10.5)

A. On cephalometric radiograph, it can be seen with the naked eye that upper molar intrusion has occurred. The mid-palatal mini-implant was used as a reference point for superimposition. Compare the distance from the palatal plane and occlusal surface of the upper molar in Figure 6-4-10A.

B. Tracing

C. Superimposition of tracing before and after molar intrusion. Black line is before intrusion (Figure 6-4-10), and red line is after intrusion. With upper molar intrusion, the mandible has rotated anticlockwise to make the mandibular plane angle smaller (refer to the clinical tip).

D. Superimposition of the maxilla. Upper molar has been intruded.

E. Superimposition of the mandible.

Clinical tip ››››

Why did anti-clockwise rotation of the mandible occur even though there was no open bite?

I often receive such questions when presenting this case. When there is a severe curve of Spee in the mandible, use of a continuous archwire will cause not only extrusion of the lower molar but also intrusion of the lower incisors. This allows space to be made between the upper and lower incisors for anti-clockwise rotation of the mandible to occur.

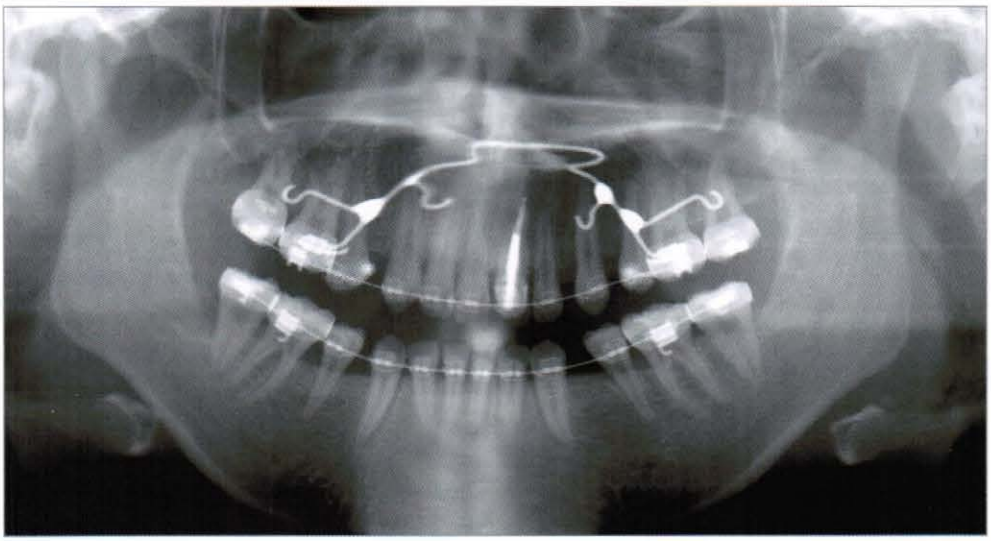


Figure 6-4-12. Leveling was begun using continuous archwires after segmental intrusion of the upper molars (2004. 10.5)
There were no side-effects such as root resorption during upper molar intrusion.

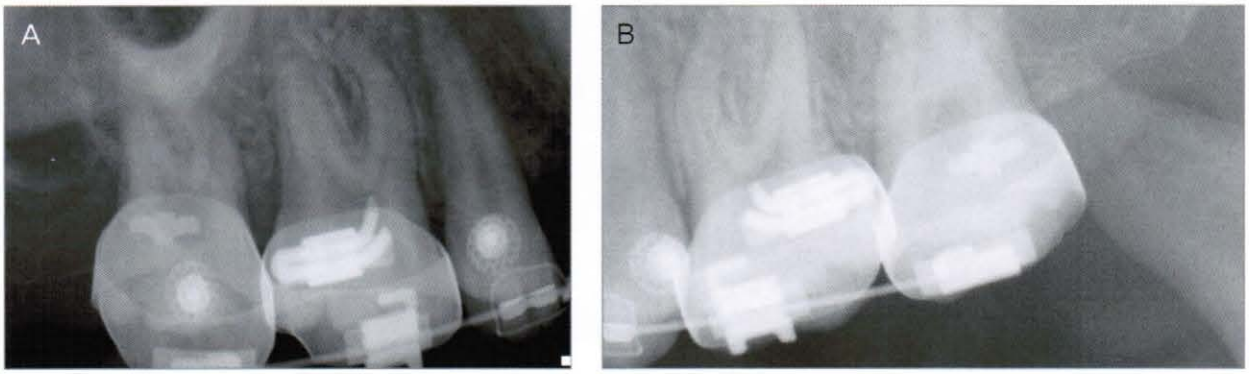


Figure 6-4-13. Periapical radiograph after leveling (2004. 10.27)
Periapical radiographs were taken to check the buccal interradicular areas for mini-implant insertion. They will be used as anchorage reinforcement during incisor retraction. The interradicular area between the first and second molars was wider than between the second premolar and first molar, so mini-implants were planned to be inserted between the first and second molars.

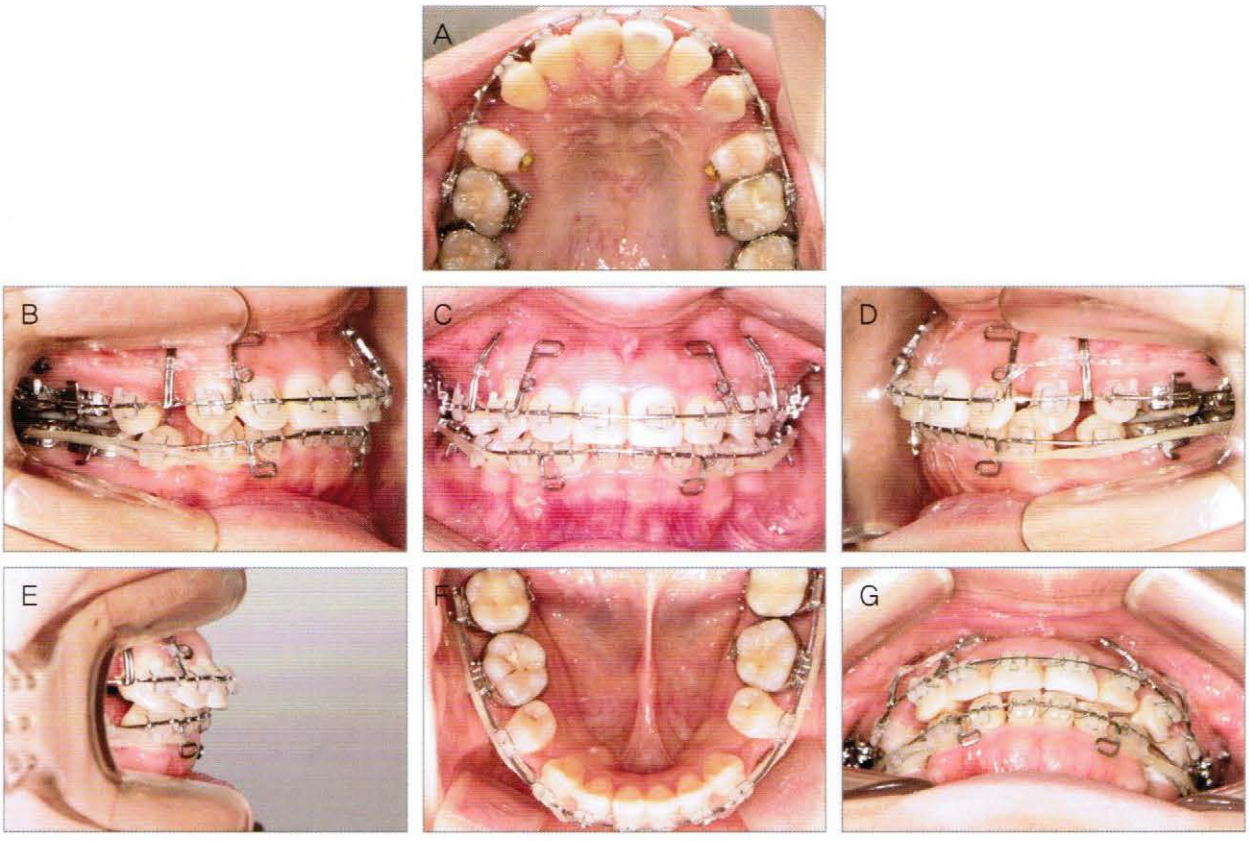


Figure 6-4-14. Space closure from upper incisor retraction (2004. 11.10)
1.6×6.0mm mini-implants were inserted between the first and second premolars. 019×025″ ss with long shoe hooks are being used for space closure. I must point out that the circle hooks on the long shoe hooks seen in photos B and D should be positioned higher to be closer to the center of resistance. 018×022″ ss shoe hooks were used in the lower arch.

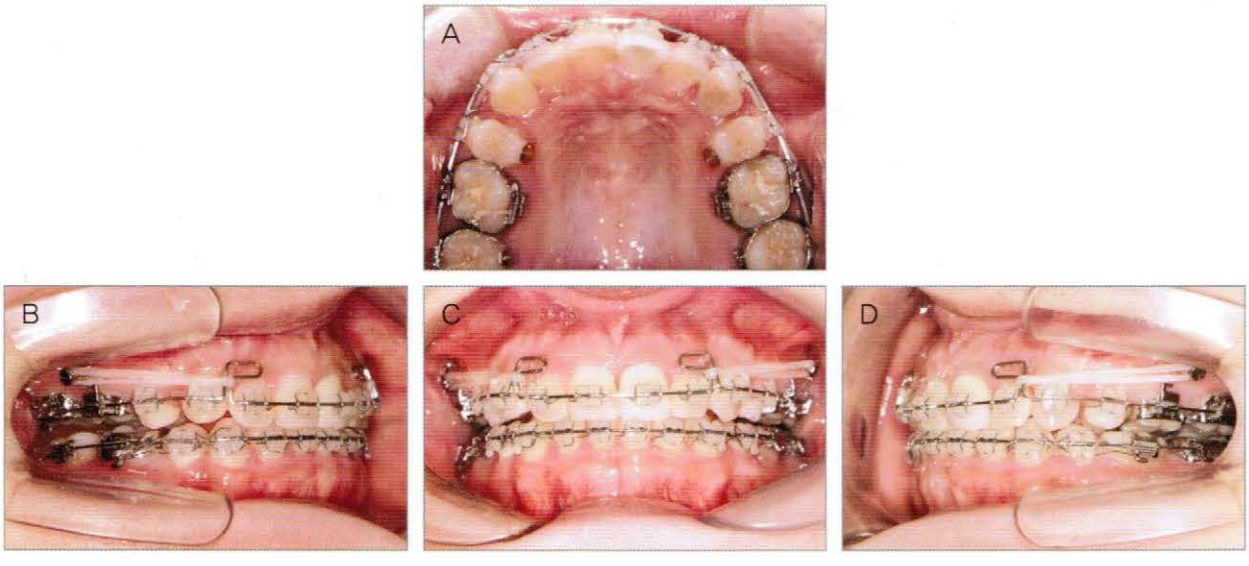


Figure 6-4-15. Final stages of space closure and detailing (2005. 6.22)
In the final stages of space closure (2005. 4.12), the upper wire was changed to 019×025" ss with shoe hooks. In the detailing stage, this wire was used to apply crown labial torque to the upper incisors. Reverse curve in the 018×022" ss wire of the lower arch helped resolve the curve of Spee (compare with Figure 6-4-14B, D).

Figure 6-4-16. Electrosurgery appliance for gingivectomy
Gingivectomy was carried out under local anesthesia in the 'Cut/Coagulation' (arrow) mode. For patient convenience, simple gingivectomy procedures are done in our Orthodontics Department (Parkell Electronics Division, Farmingdale, New York, USA).

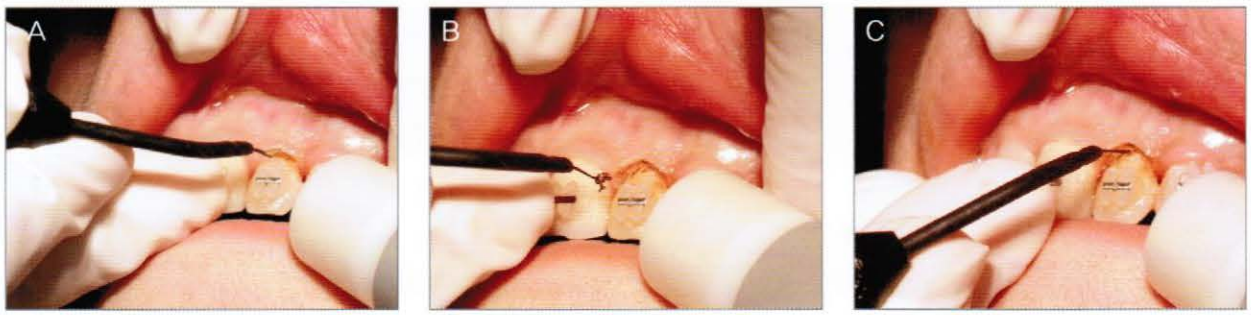


Figure 6-4-17. Gingivectomy being carried out on the upper left lateral incisor (2005. 6.22)
By carrying out gingivectomy on the upper incisors at the detailing stage, one of the causes of gummy smile has been eliminated.

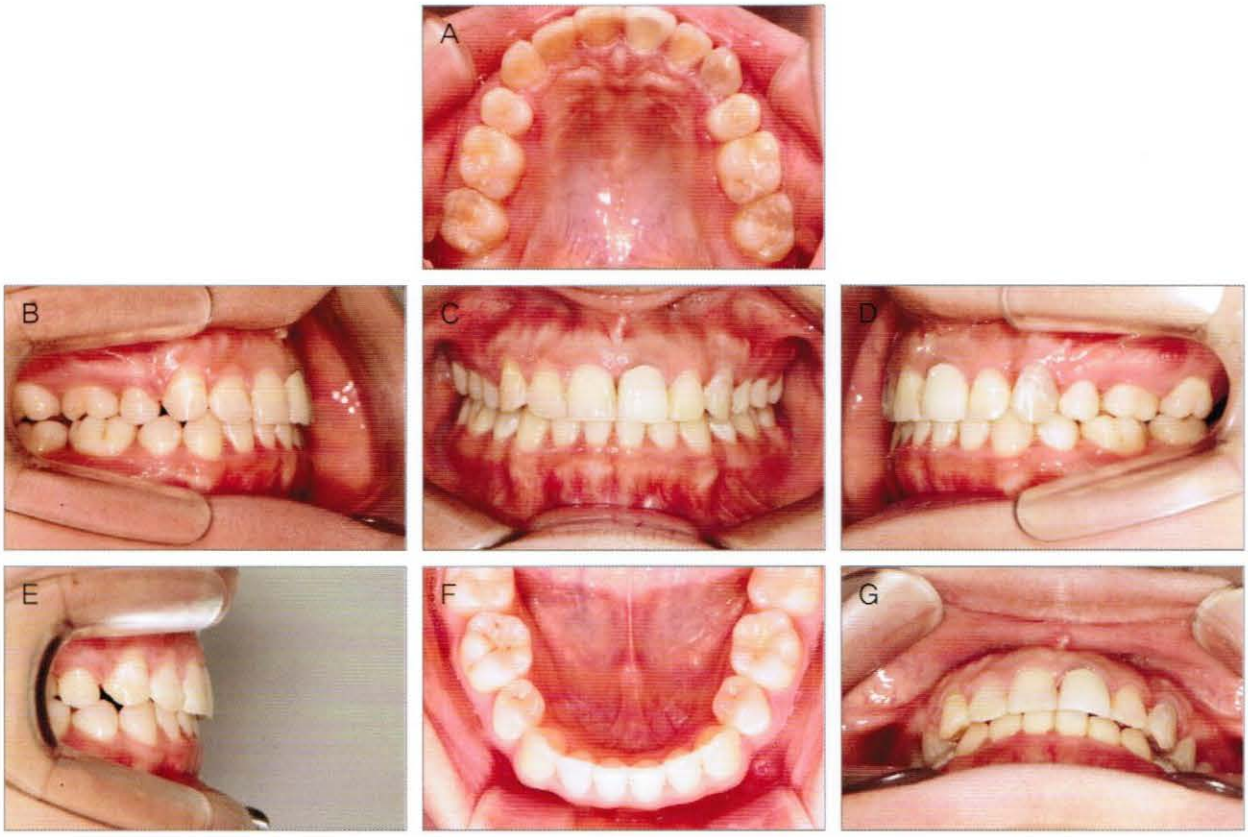


Figure 6-4-18. Intraoral photograph at debonding (2005. 8.10)
A more natural gingival line has been achieved after gingivectomy as the upper incisor crown length has increased. A narrow upper right second premolar antero-posteriorly has caused small extraction spaces to be left open.

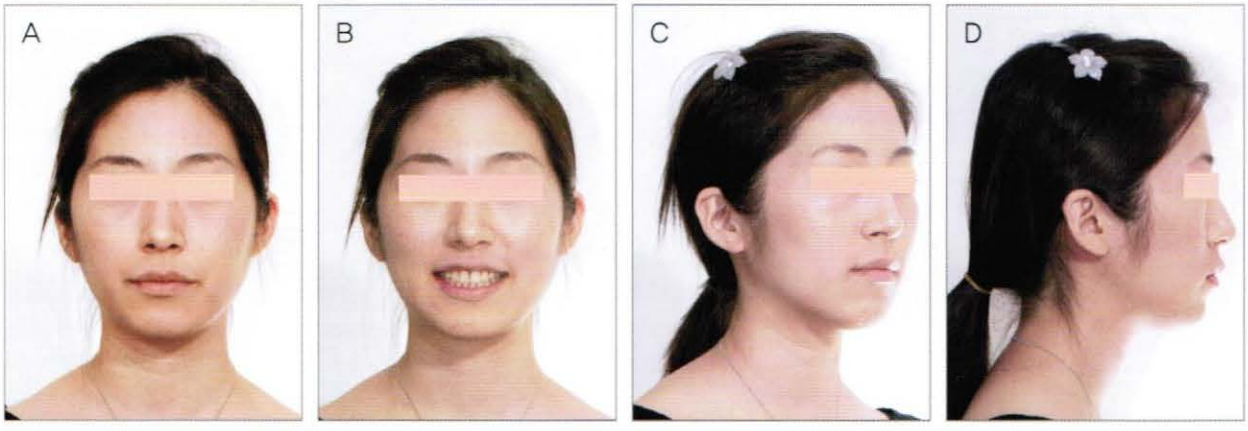
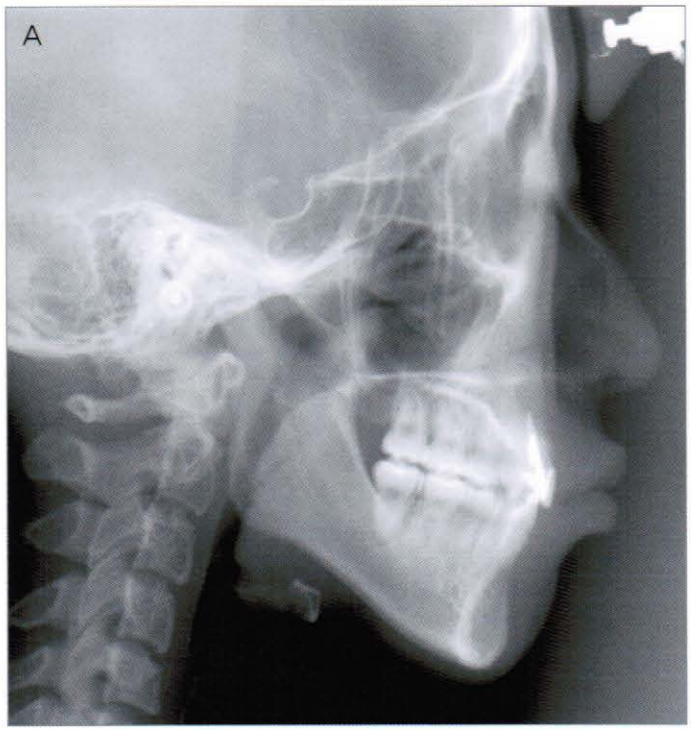
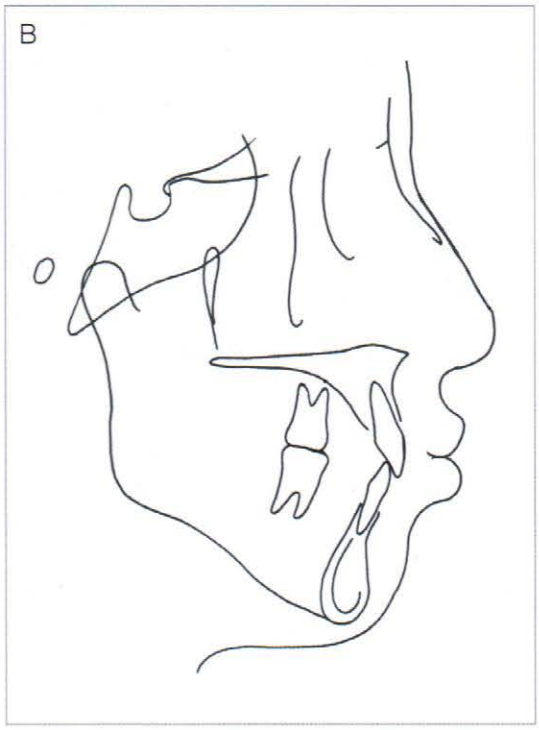


Figure 6-4-19. Facial photographs at debonding (2005. 8.10)
She shows good facial proportions with treatment of gummy smile.


A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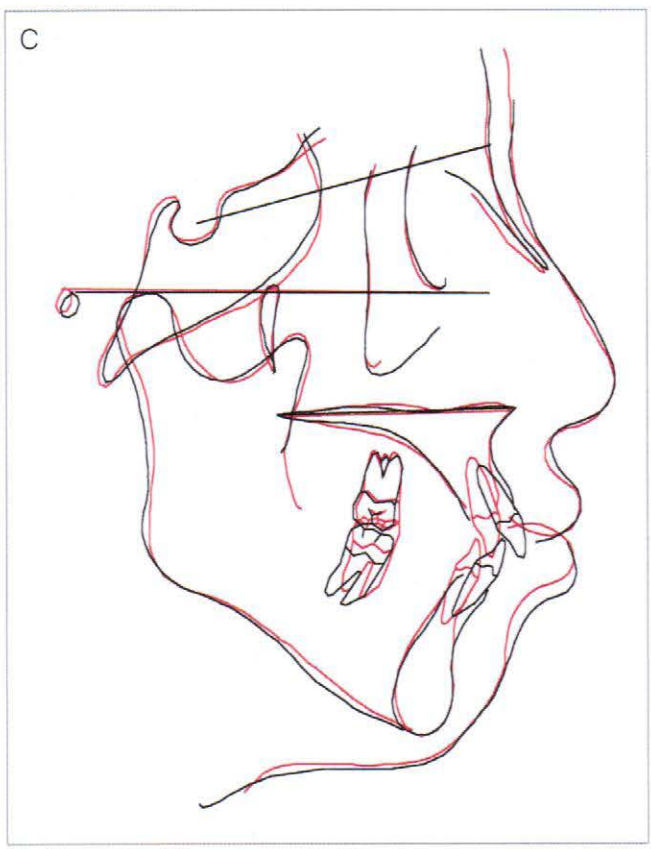
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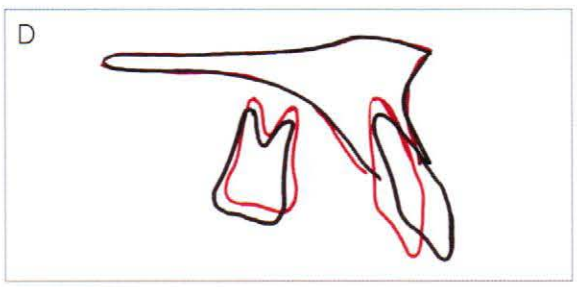
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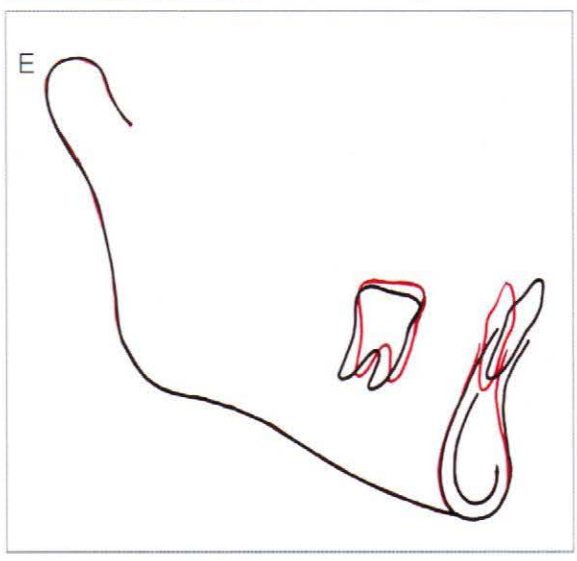

E

F

	Norm	SD	T1	T2
SNA	81.6	3.2	75.6	76.0
SNB	79.2	3.0	71.3	71.2
ANB	2.5	1.8	4.4	4.8
FMA	24.3	4.6	31.1	31.7
ODI	72.2	5.5	67.6	68.0
U1 to FH	116.0	5.8	115.5	103.1
IMPA	95.9	6.4	93.0	80.8
IIA	123.8	8.3	120.4	144.5
Esth-U	-0.9	2.2	4.4	1.9
Esth-L	0.6	2.3	8.1	3.9

Figure 6-4-20. Cephalometric radiograph and measurement at debonding
A. Post-treatment cephalometric radiograph. She has a habit of protruding the lower lip on mouth closure.
B. Post-treatment cephalometric tracing
C. Pre- and post-treatment superimposition of tracing (Upper molar intrusion has occurred. The anti-clockwise rotation effect of the mandible due to extrusion of lower molars has disappeared).
D. Superimposition of the maxilla. Upper first molar intrusion and upper incisor intrusion has occurred.
E. Superimposition of the mandible. Lower first molar extrusion and lower incisor intrusion has occurred.
F. There has been linguoversion of both upper and lower incisors. Mouth protrusion has been relieved.

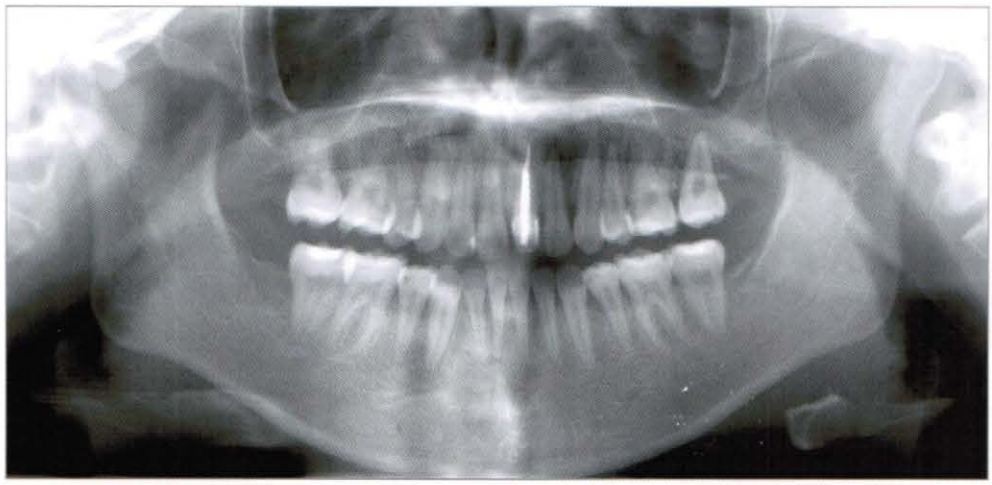


Figure 6-4-21. Panoramic radiograph at debonding
Resorption has not occurred.

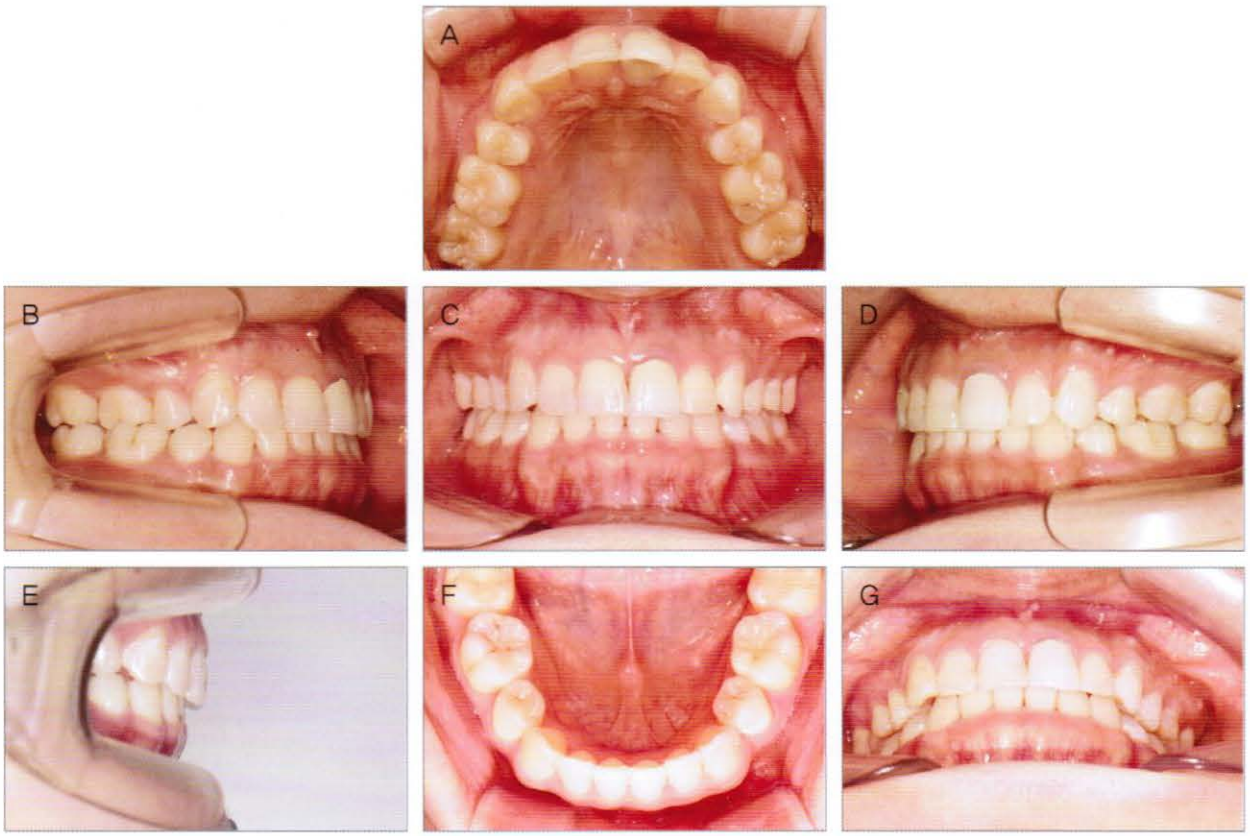
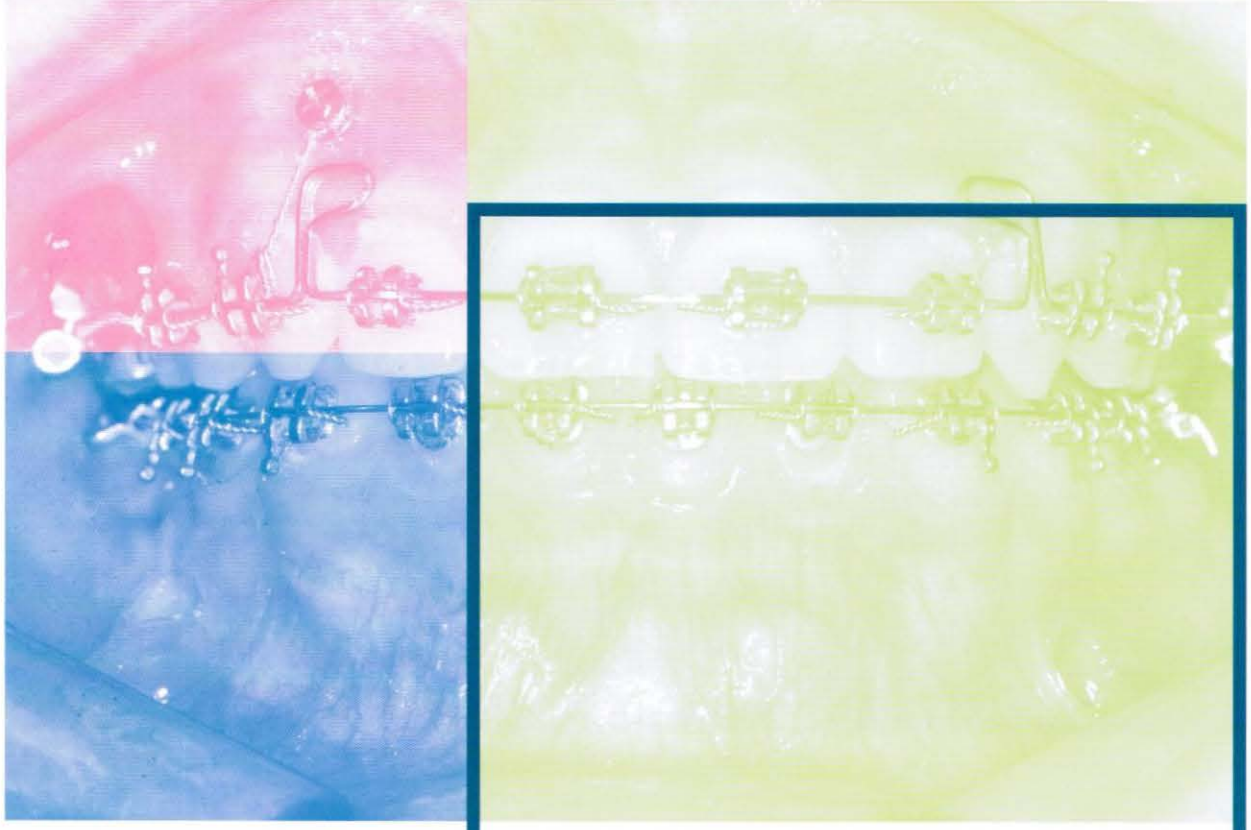


Figure 6-4-22. Intraoral photograph after 1 year of retention (2006. 8.18)
The occlusion is stable.

Figure 6-4-23. Facial photograph after 1 year of retention (2006. 8.18)



Chapter 7

Distalization of upper molars

Chapter 7 Distalization of upper molars

I . SPA appliance

Traditional methods for distalization of upper molars include appliances such as cervical headgear and Pendulum appliance. The disadvantage of cervical headgear is that the patient feels much discomfort. With the Pendulum appliance, the anchor teeth may move forward. However mini-implants may be used for molar distalization without the need for patient compliance. Also there is no danger of loss of the anchor teeth forward as with the Pendulum appliance.

The SPA appliance introduced in this chapter has been developed by one of my students, Dr. Kyung-Soo Nahm. This appliance has been modified into many varieties for use clinically. It was first used only in the palatal side with the name S-shaped palatal arm, but with recent use buccally, the name has been changed into Sigmoid parallel arm.

The characteristic of this appliance is that it uses the most frequently used mini-implant between the second premolar and first molar. By observing cases for each indication, it will be easy to understand use of the SPA.

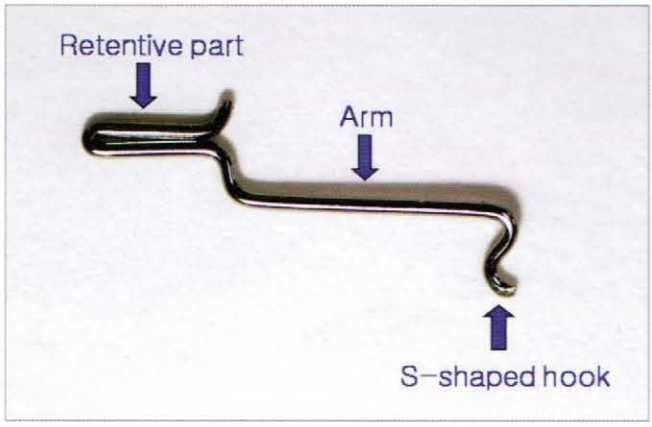


Figure 7-1-1. First type of SPA developed
The first letters of 'S-shaped palatal arm' was used for the name SPA.

Figure 7-1-2. Structure of SPA used initially
A, B. SPA manufactured on study model
C. It is inserted into the palatal sheath and power chain applied. Construction of each SPA type will be explained.

Type of SPA

1. Palatal SPA
2. Buccal SPA
3. TPA + SPA

Each SPA has characteristics, advantages and disadvantages. The type of SPA can be chosen by considering the position of the mini-implant, but a more scrupulous consideration of the mechanics will bring better results.

1. Palatal SPA

Structure (Figure 7-1-3)

1) Band : first molar bands must be made.
2) Palatal sheath : palatal sheath used for TPA is welded onto the palatal surface.
3) 0.9mm stainless steel round wire
4) 1.6x6.0mm mini-implant : inserted between the second premolar and first molar.
5) Power chain or elastic thread : hooked between the mini-implant head and SPA hook.

Figure 7-1-3. Structure of palatal SPA

Manufacturing process of palatal SPA (Figure 7-1-4~8)

Each step is explained with corresponding photographs.

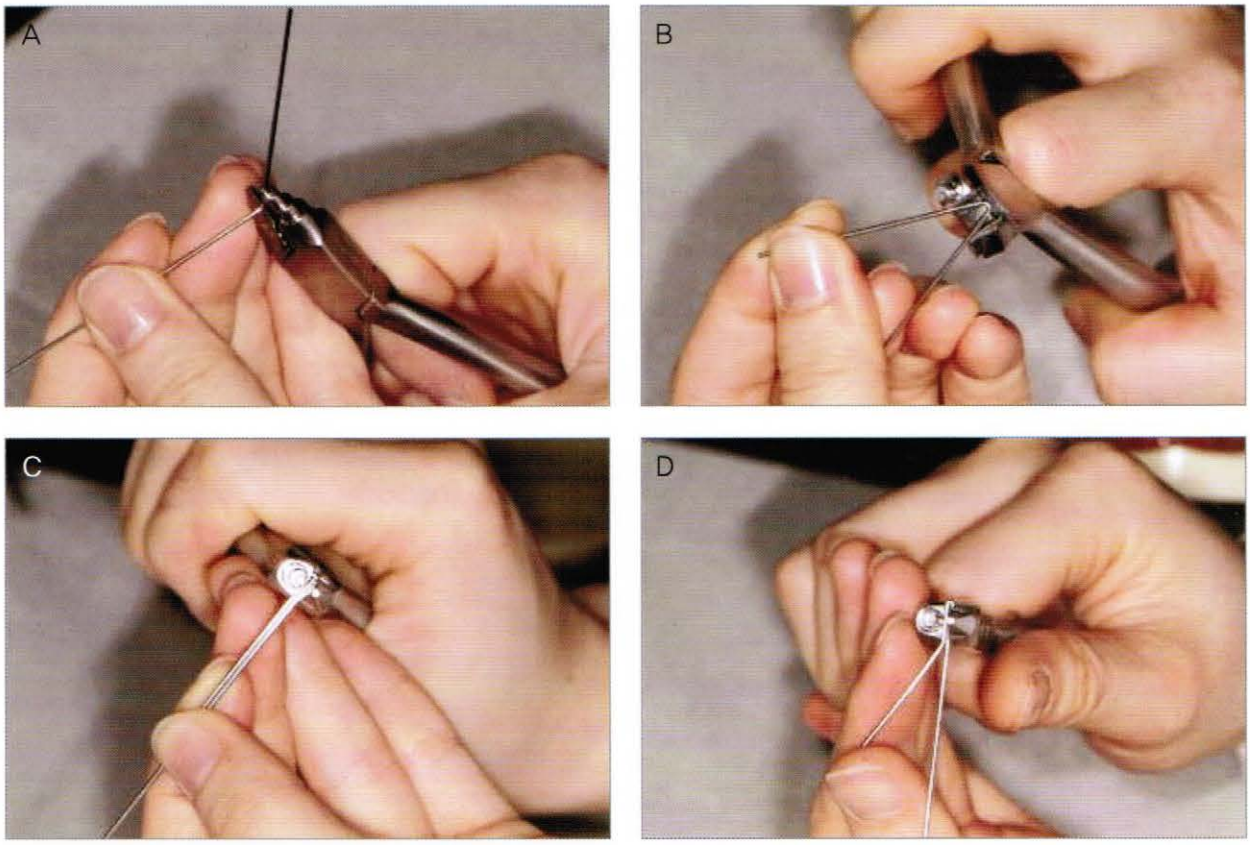
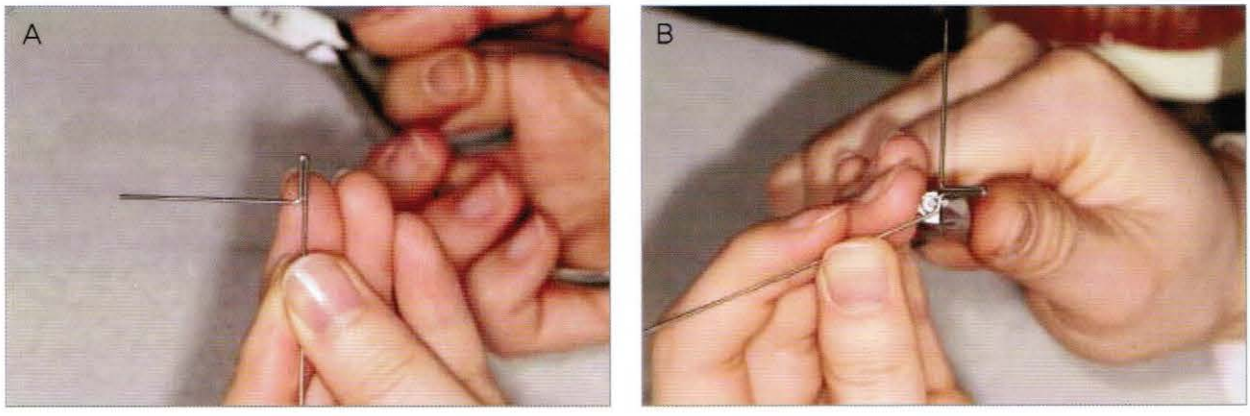


Figure 7-1-4. Retentive part which will be inserted into the palatal sheath
A. 0.9mm wire is bent at an acute angle slightly longer than the palatal sheath.
B. Using the groove in Young's plier, the two ends of the wire are bent.
C. And squeezed.
D. Bend the short end 90° to make the stop which will face the occlusal surface.



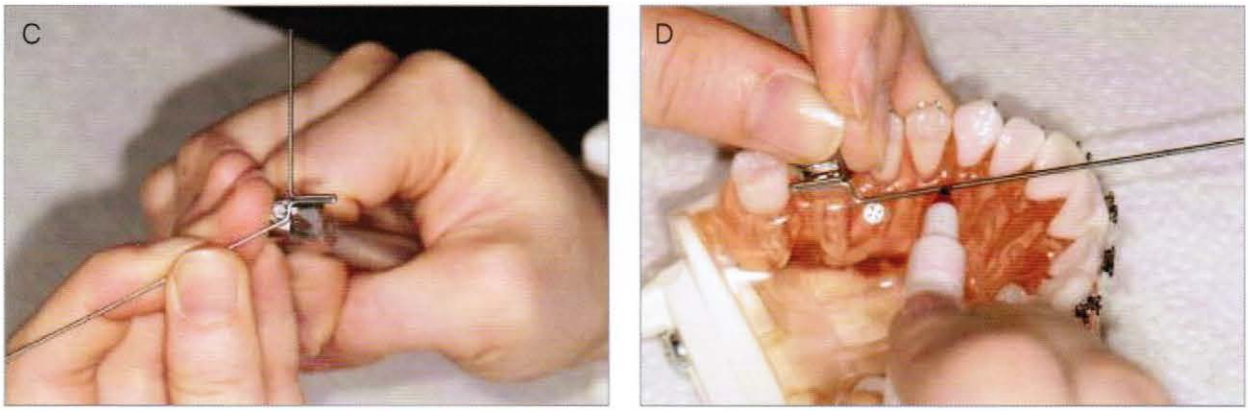


Figure 7-1-5. Bayonet bend
A. The stop to face the occlusal surface has been bent.
B. Bend the wire 90° towards the tooth apex, then at an appropriate length (around 5mm. Some changes to this length can be made, its effects will be explained in the biomechanics section), bend again 90° towards the back.
C. Make a bayonet shape.
D. Make sure on the study model that the mini-implant head does not catch on the wire. Mark the point where the S-hook is to be bent. Between the canine and first premolar is a good point.

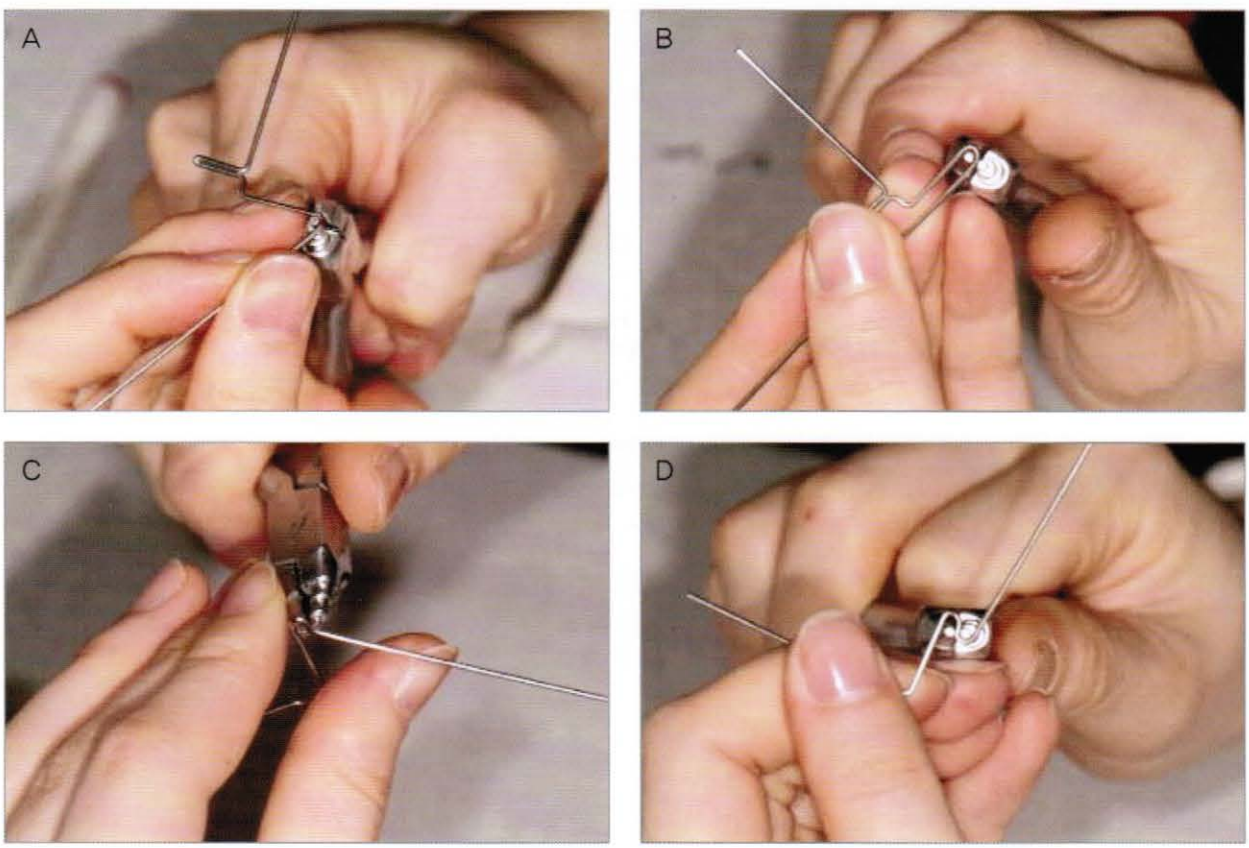


Figure 7-1-6. S-shaped hook
A, B. Use the round tip of Young's plier to bend the wire towards the apex.
C, D. Using the round tip of Young's plier again, the wire is bent again in the opposite direction.

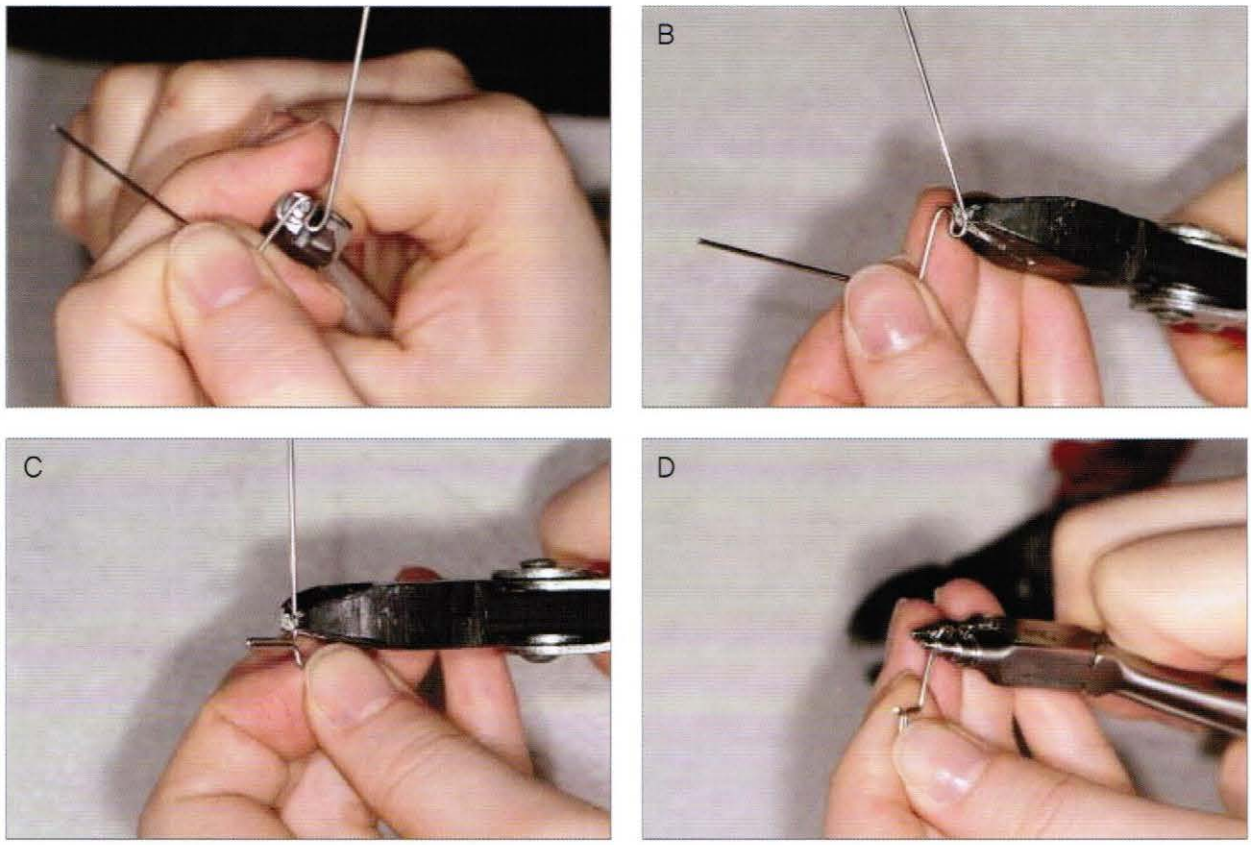
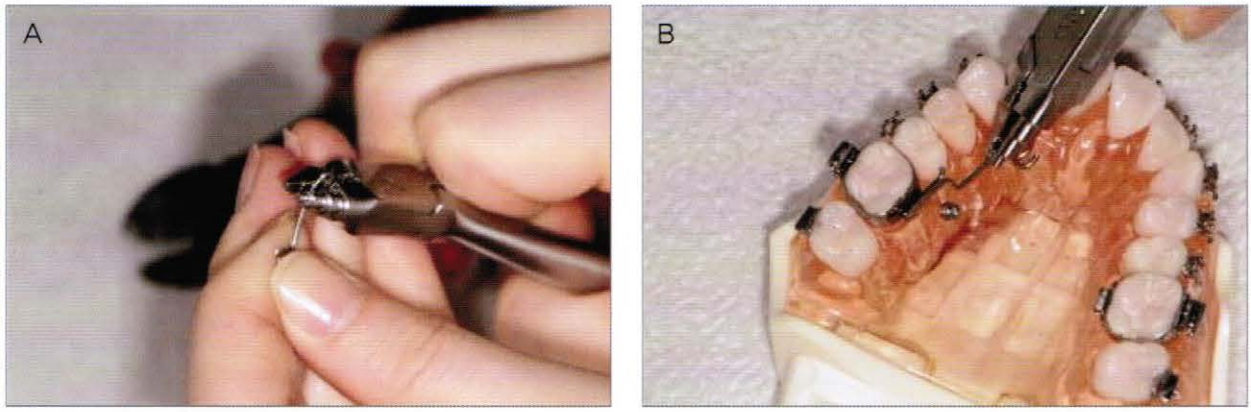


Figure 7-1-7. S-shaped hook and contouring
A. Squeeze the hook lightly and to make it smaller.
B. Cut the end of the hook and polish.
C. Cut the end leaving a small portion of the stop of the retentive portion. Polish to make sure it causes no harm to the tongue.
D. Contour to fit the shape of the hard and soft palate.



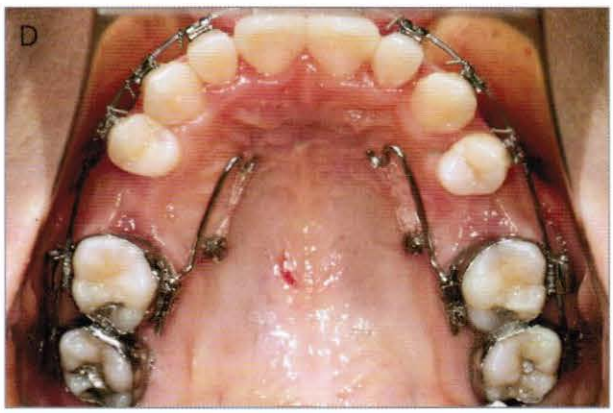


Figure 7-1-8. Contouring and adjustment
A. Wire is contoured to fit the palate.
B. Check on the study model.
C. Finished structure on the study model.
D. Adjustments are needed to fit into the patient's mouth. Make sure that it doesn's impinge on the palate or sits too far away from it. Check that the position of the hook is appropriate. Place power chain or elastic thread from the mini-implant head to the hook to apply force.

Advantages

1. Because the interradicular distance between the second premolar and first molar in the palate is wider, there is less risk of root damage during mini-implant insertion.
2. Because the interradicular distance between the first premolar and first molar is wide, a lot of tooth movement is possible.
3. Stability is better than the buccal side.
4. Compared to TPA + SPA, there is less discomfort for the patient, and distalization of the upper molars on one side is possible.
5. It is stronger than the buccal SPA.

Disadvantages

1. It is bulky to the tongue than compared with the buccal SPA.

2. Buccal SPA

Structure (Figure 7-1-9)

1) Band : first molar bands must be made.
2) Headgear tube : attach a buccal tube for use with headgear facebow.
3) 0.9mm stainless steel round wire.
4) 1.6x6.0mm mini-implant : insert between the second premolar and first molar.
5) Power chain or elastic thread : place between the mini-implant head and SPA hook.

Figure 7-1-9. Structure of buccal SPA

Manufacture of buccal SPA (Figure 7-1-10~13)

Each step is explained with corresponding photographs.

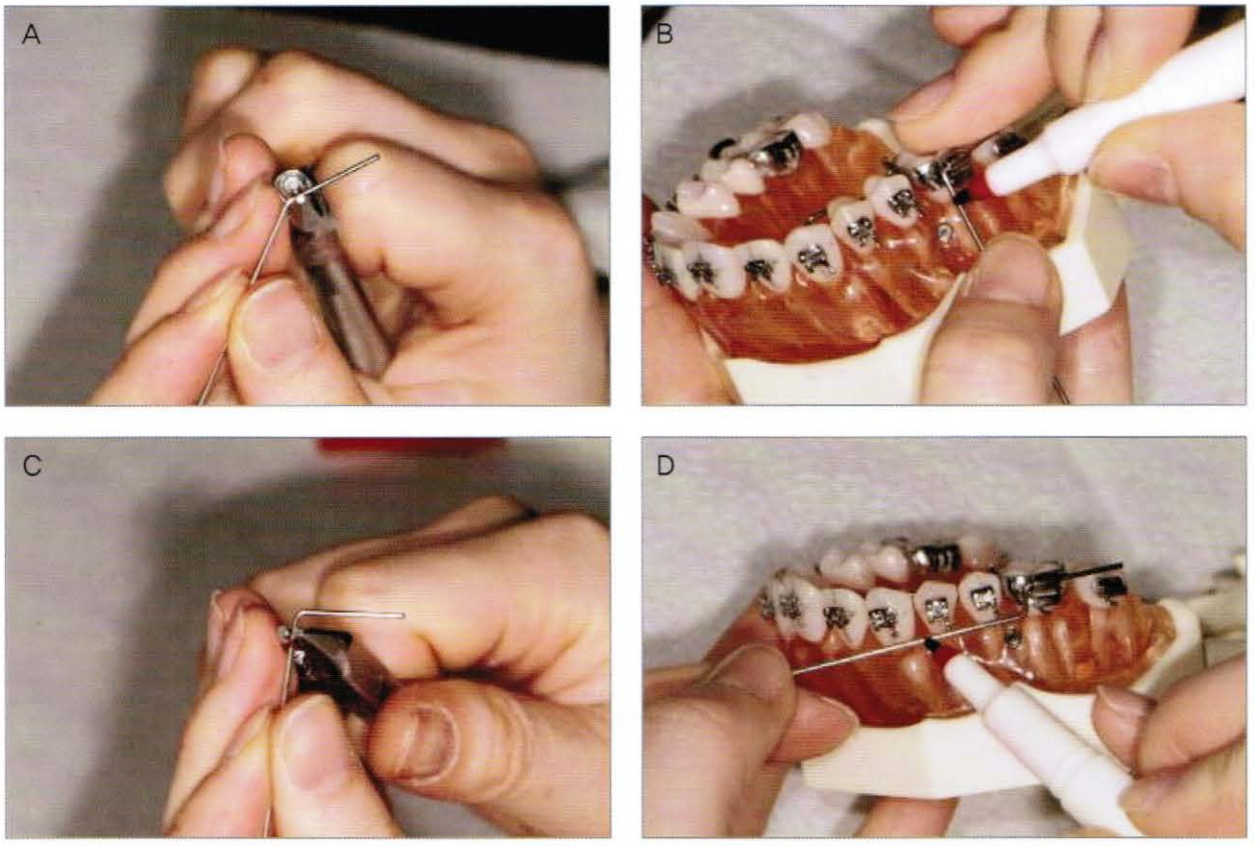


Figure 7-1-10. Bayonet bend

A. Bend the wire at 90° leaving a length slightly longer than the headgear buccal tube.

B, C. Bend again at 90° towards the distal. Bayonet has been made. This should be at a length that will not touch the implant head (Around 5mm in length, tooth movement will differ according to the wire length. Refer to the biomechanics section).

D. Mark the spot for the S-shaped hook, around the contact point between the canine and first premolar.

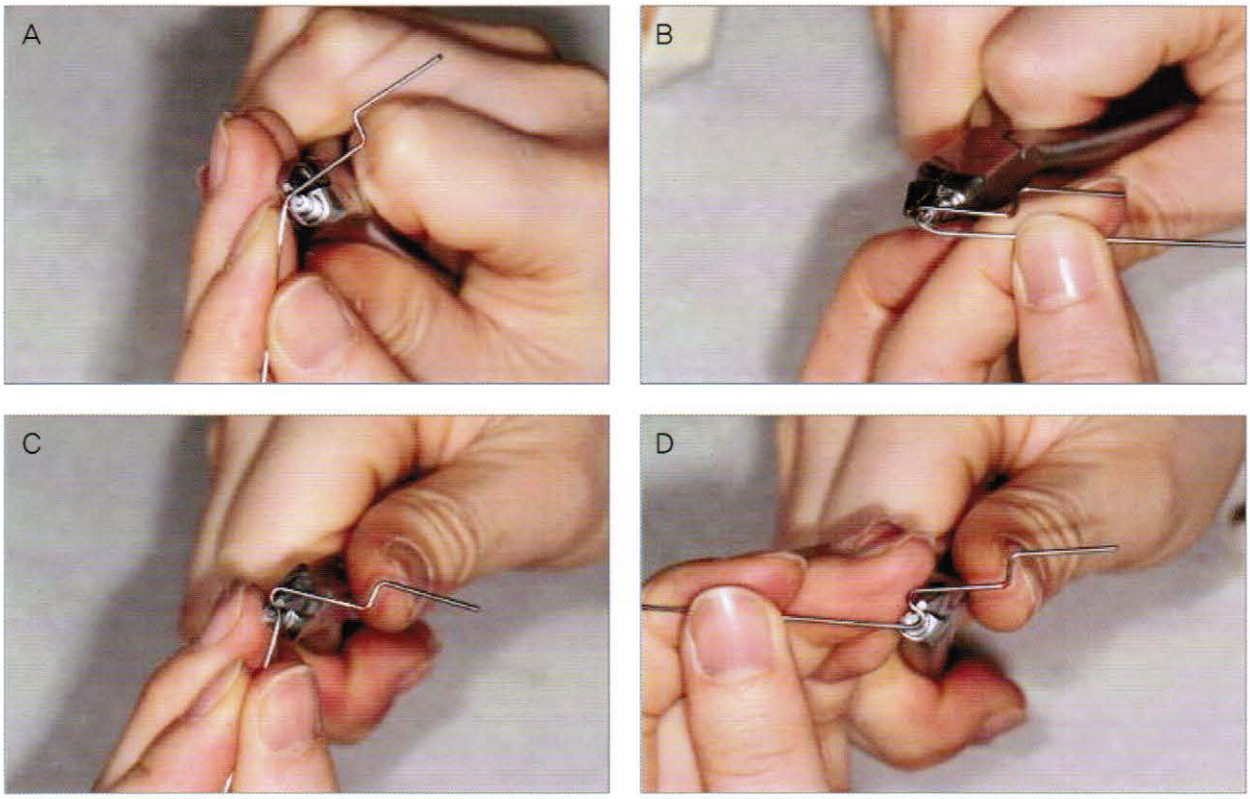


Figure 7-1-11. Bending of the S-shaped hook.
A, B. A C-shaped hook is bent toward the distal using the round tip of Young's plier.
C. Bend again toward the mesial. D. S-shaped hook is complete.

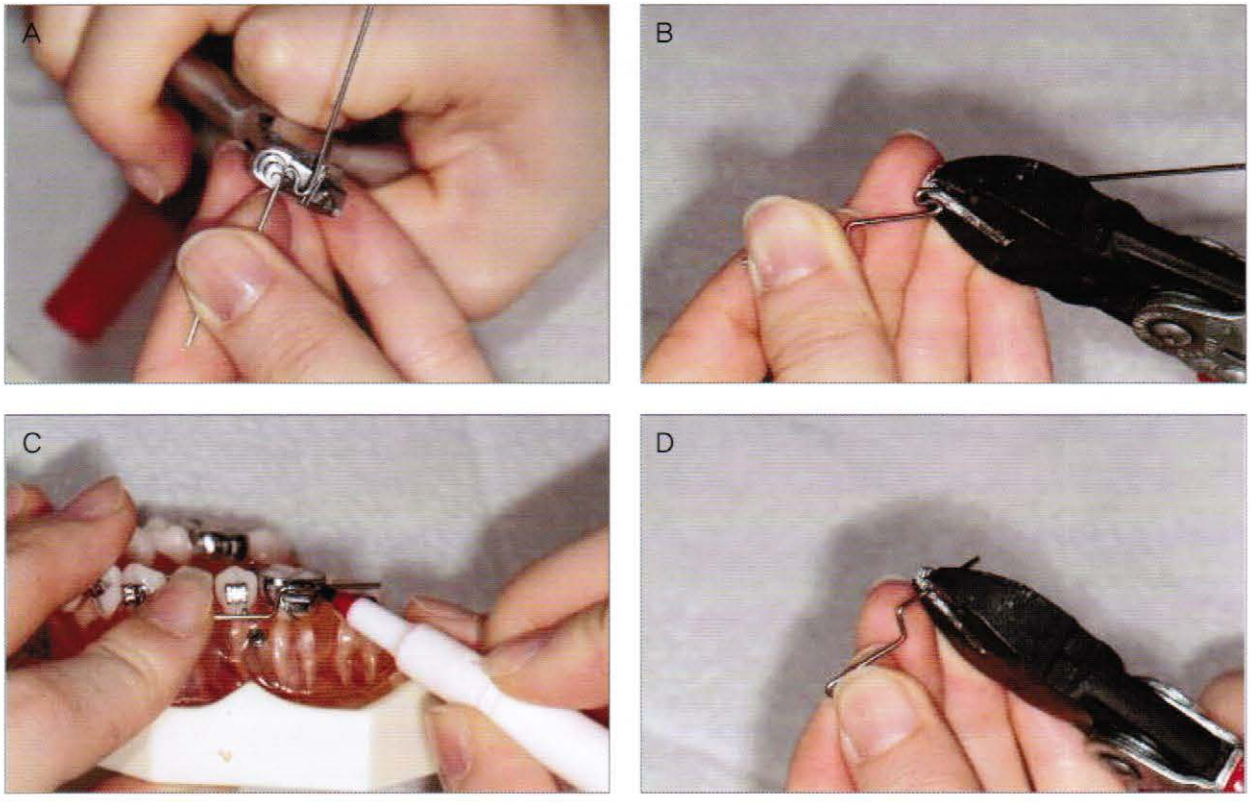


Figure 7-1-12. Finishing of the S-shaped hook and cutting of the rest
A. Squeeze the S-shaped hook as required.
B. Cut the rest of the S-shaped hook.
C. Mark the length of the wire around 1mm longer than the headgear tube.
D. Cut at the marked point.

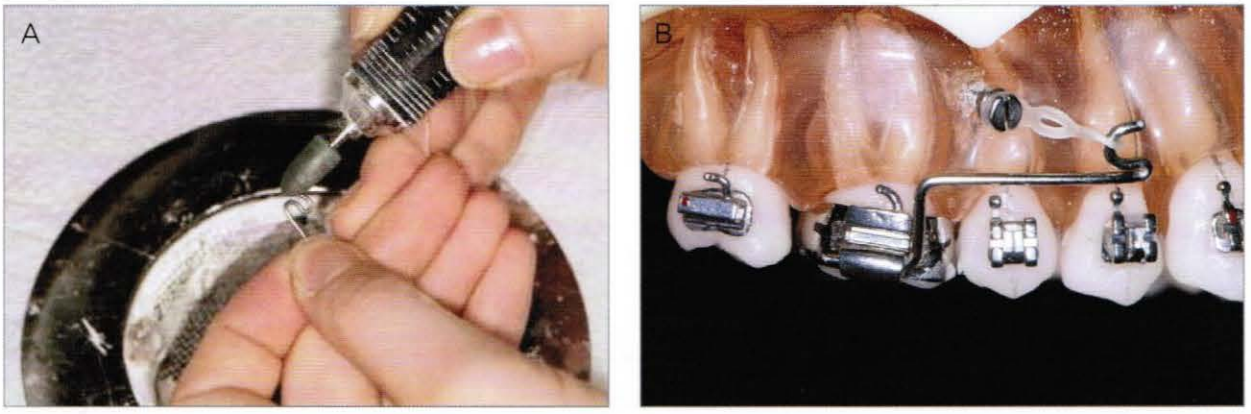


Figure 7-1-13. Polishing and application
A. Polish the sharp ends of the SPA.
B. Adjust in the mouth and apply power chain or elastic chain.

Advantages

1. Tongue discomfort is less compared to the Palatal SPA.
2. The mini-implant between second premolar and first molar can be used with the SPA to allow distalization of upper first molars, and then later used as anchorage for incisor retraction.

Disadvantages

1. Because the interradicular distance between the second premolar and first molar is narrower than the palatal side, the buccal SPA cannot allow more tooth movement than the Palatal SPA.
2. Palatal SPA is stable but the buccal SPA is more movable. It is ligated onto the second premolar bracket using ligature wire.

3. TPA + SPA

Structure (Figure 7-1-14)

1) Band : first molar bands must be made.
2) Palatal sheath : palatal sheath used for TPA is welded onto the palatal surface.
3) 0.9mm stainless steel round wire.
4) 1.6x6.0mm mini-implant : insert between the second premolar and first molar.
5) Power chain or elastic thread : place between the mini-implant head and SPA hook.

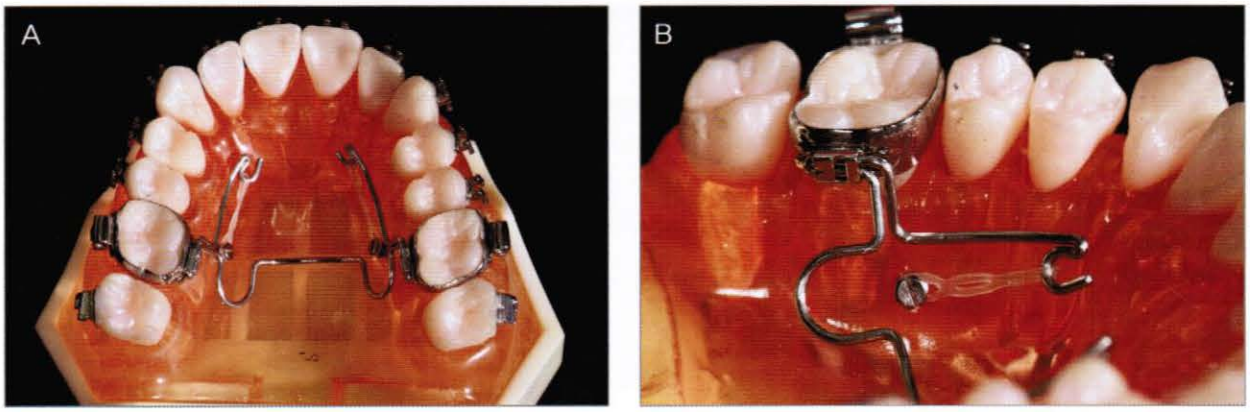


Figure 7-1-14. Structure of TPA + SPA

Manufacturing process of TPA + SPA (Figure 7-1-15~26)

Each step is explained with corresponding photographs.

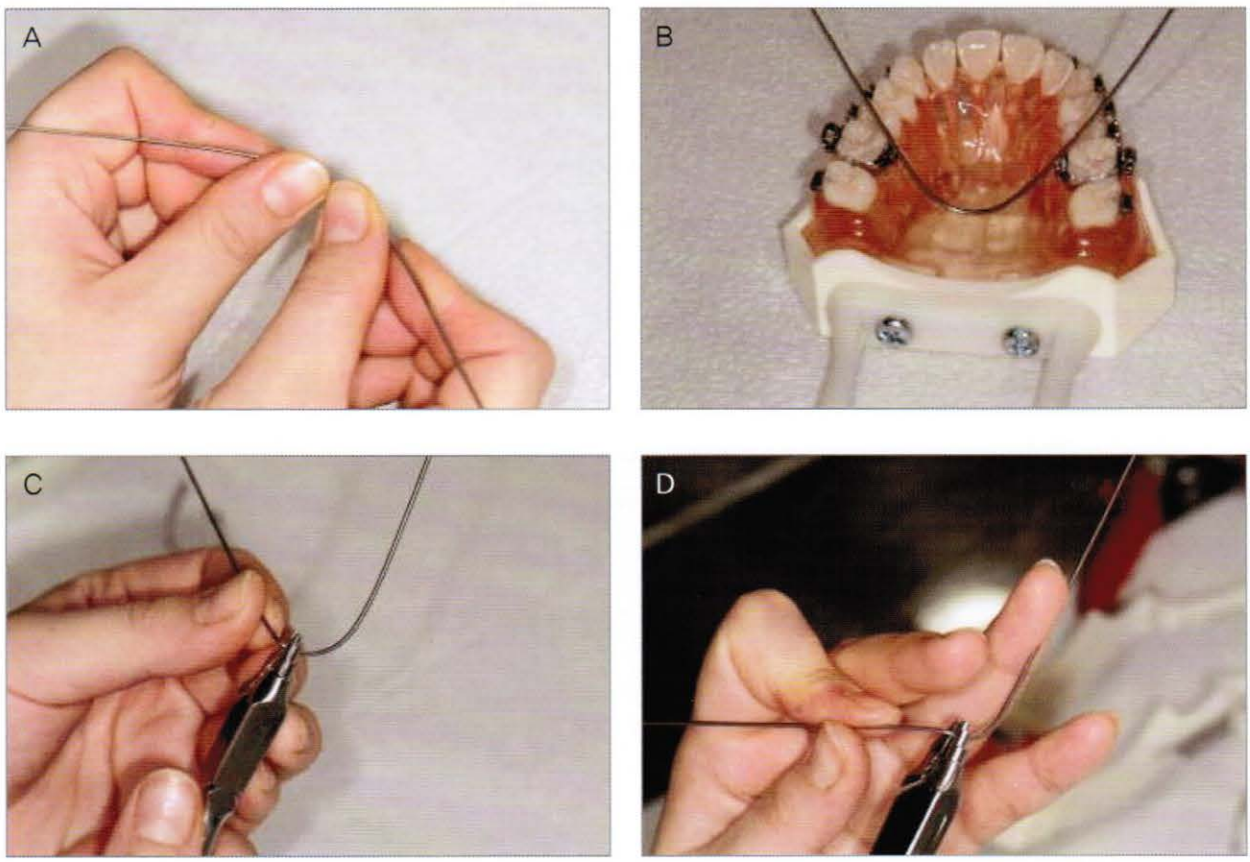


Figure 7-1-15. Construction of the TPA portion
A. Wipe the wire to conform to the shape of the palate.
B. Mark the points where the U-loops will be bent.
C, D. Wire is bent at 90° distally.

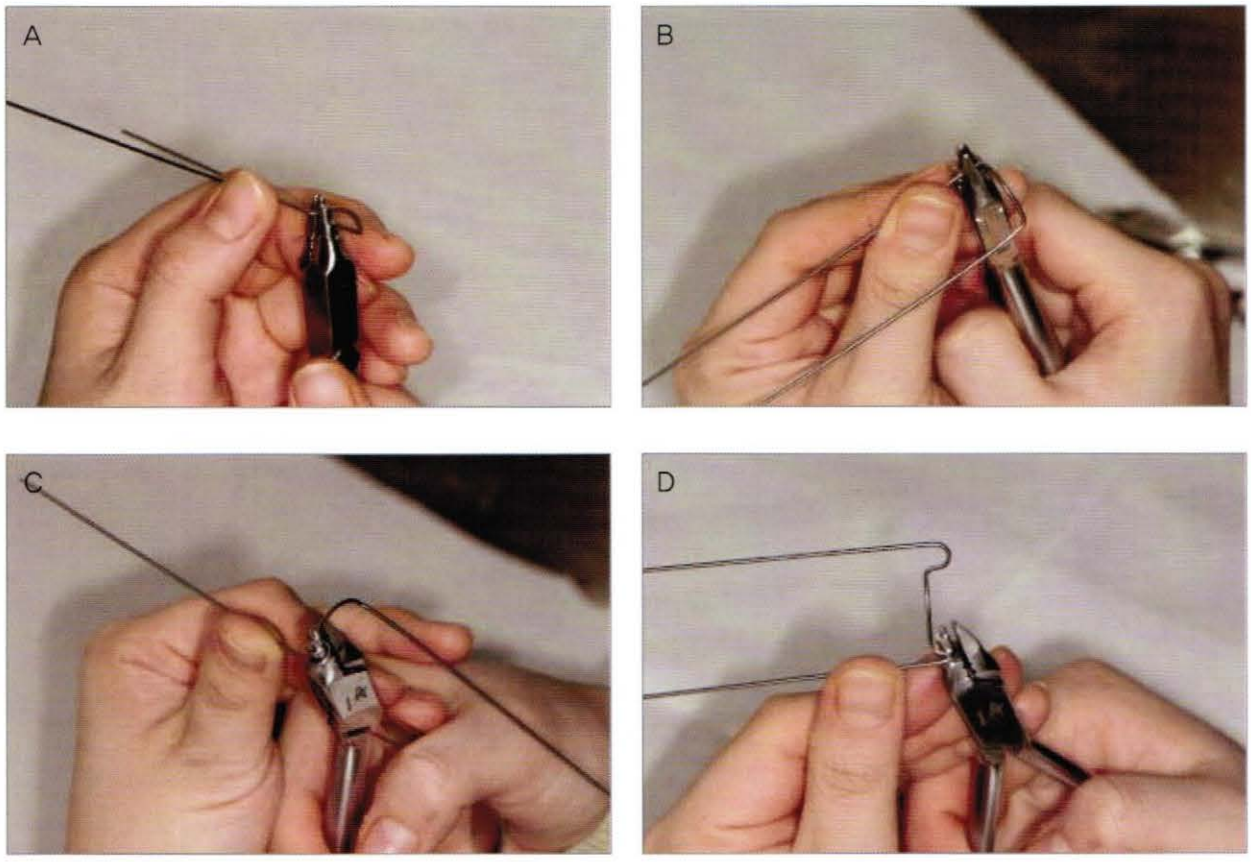


Figure 7-1-16. Construction of U-loop
A, B. To make two U-loops, the TPA is bent at 90° distally at the marked point.
C. The first U-loop is being bent.
D. The second U-loop is being bent.

Clinical tip ››››

Role of two U-loops in TPA + SPA

1) At first a conventional TPA with one U-loop in the center was used. However there were times when the TPA bar would catch on the mini-implant head and make it difficult to insert the TPA into the palatal sheath. Two U-loops allow enough space for the TPA + SPA to be inserted into and removed from the palatal sheath.
2) TPA width can be adjusted.

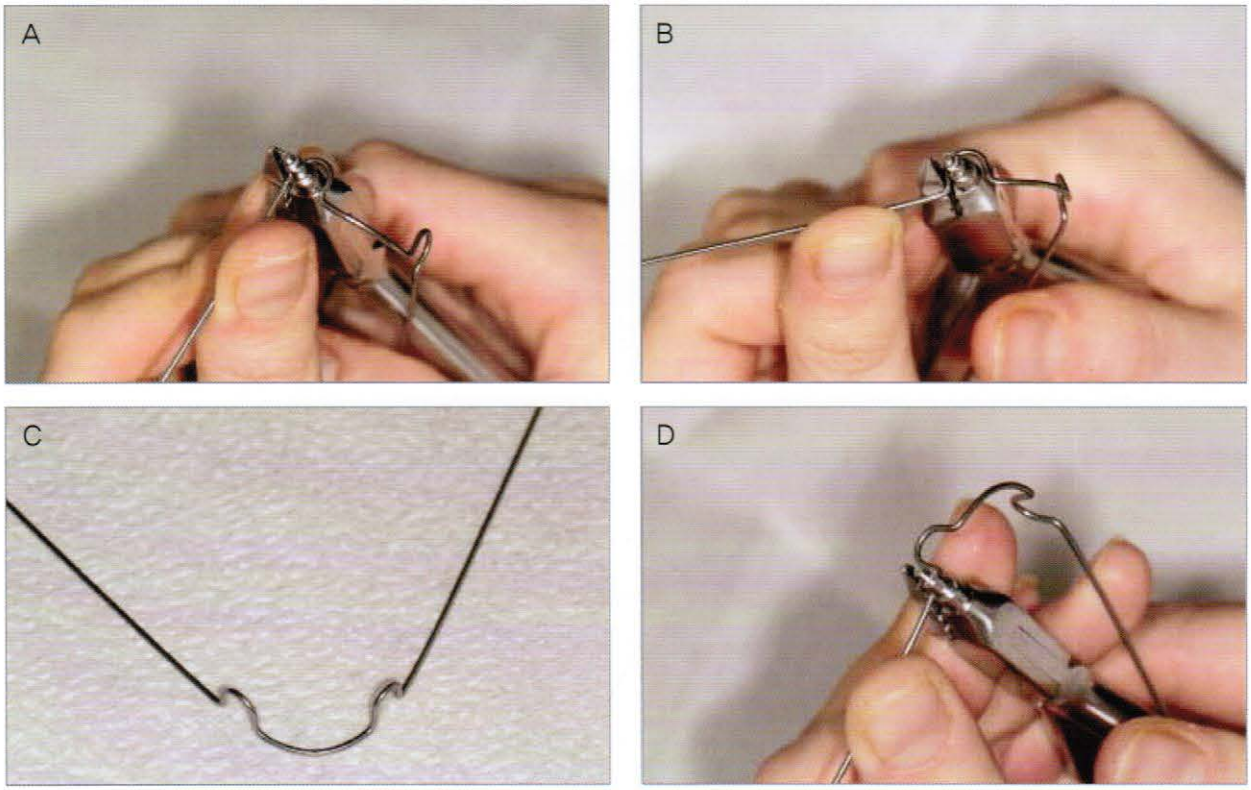


Figure 7-1-17. Completed U-loop
A, B, C. Create a U-loop and adjust the TPA again to fit the palate.
D. To create the retentive part to be inserted into the palatal sheath, mark the appropriate spot and bend 90° in the same direction as the U-loop.

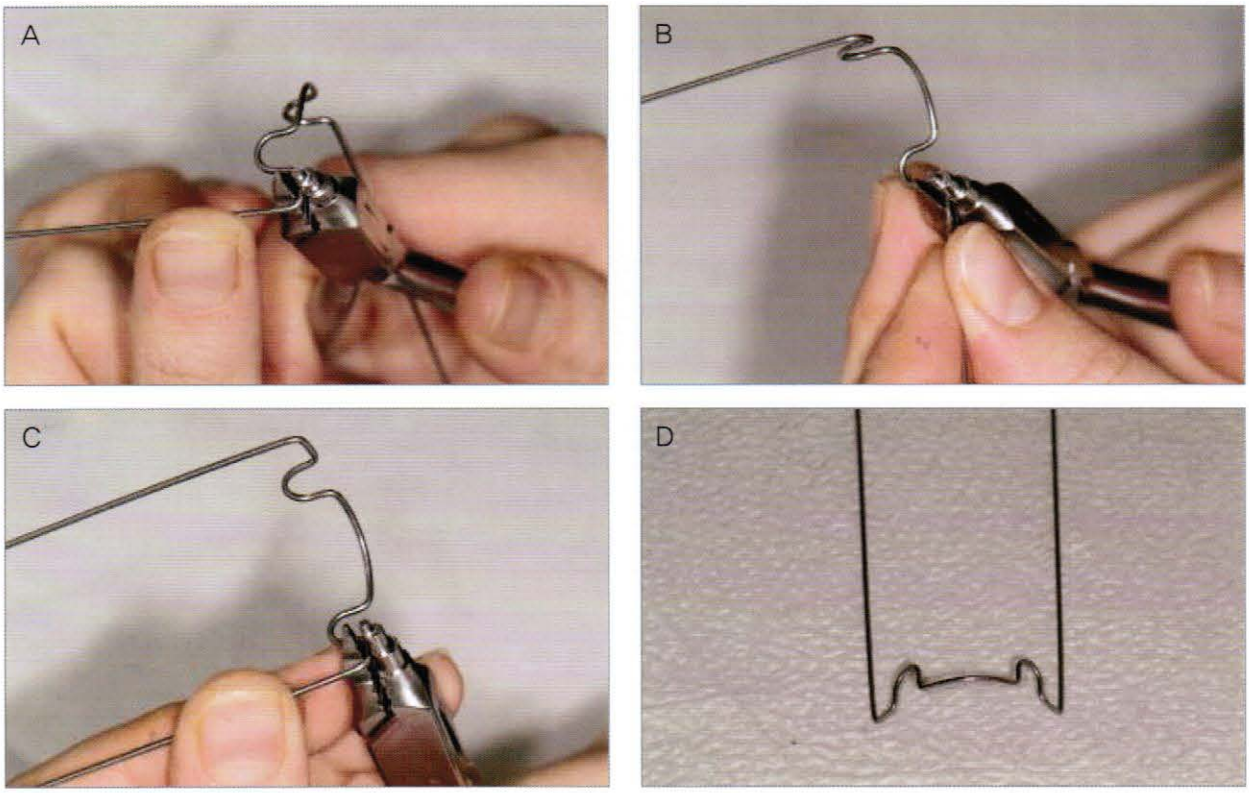


Figure 7-1-18. Construction of the retentive part to be inserted into the palatal sheath
Bend both ends of the TPA 90° distally.

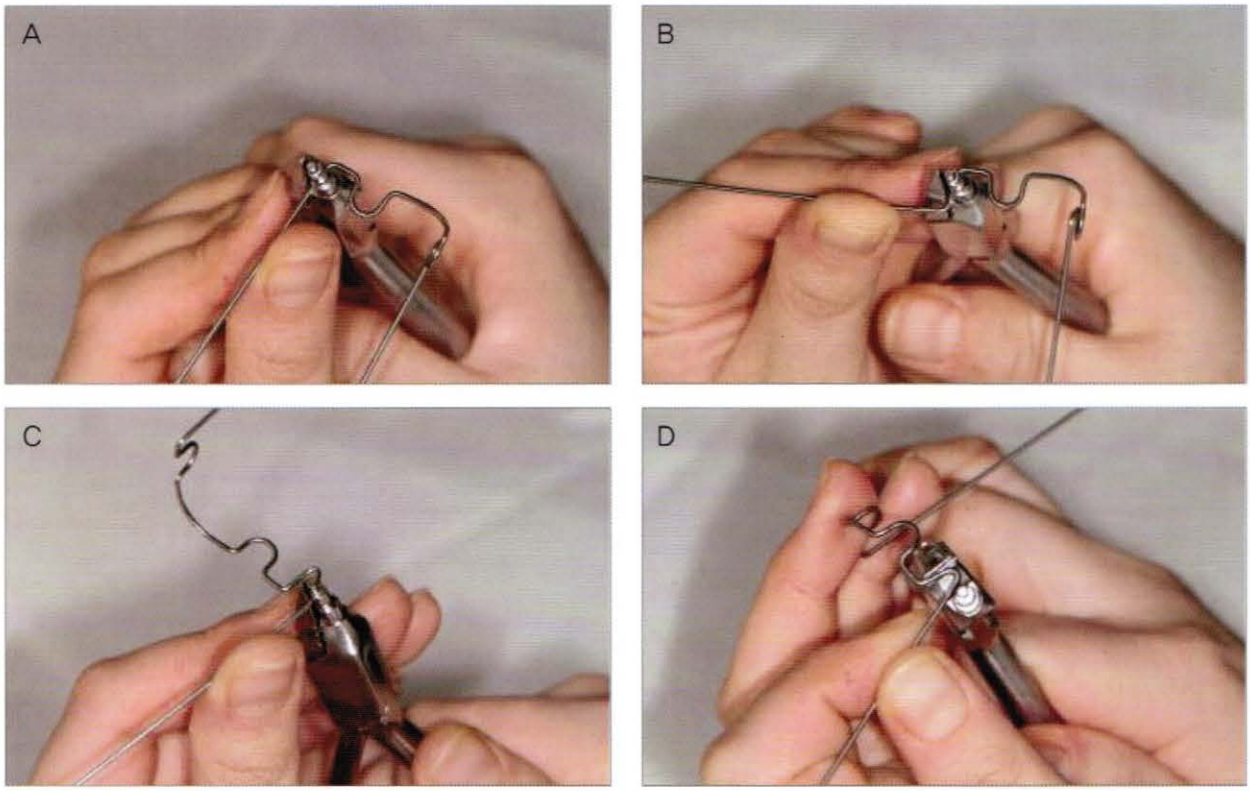


Figure 7-1-19. Bending of the retentive part which will insert into the palatal sheath
A, B, C. Bend a smaller U-loop at a length slightly longer than the palatal sheath. D. Squeeze tightly together.

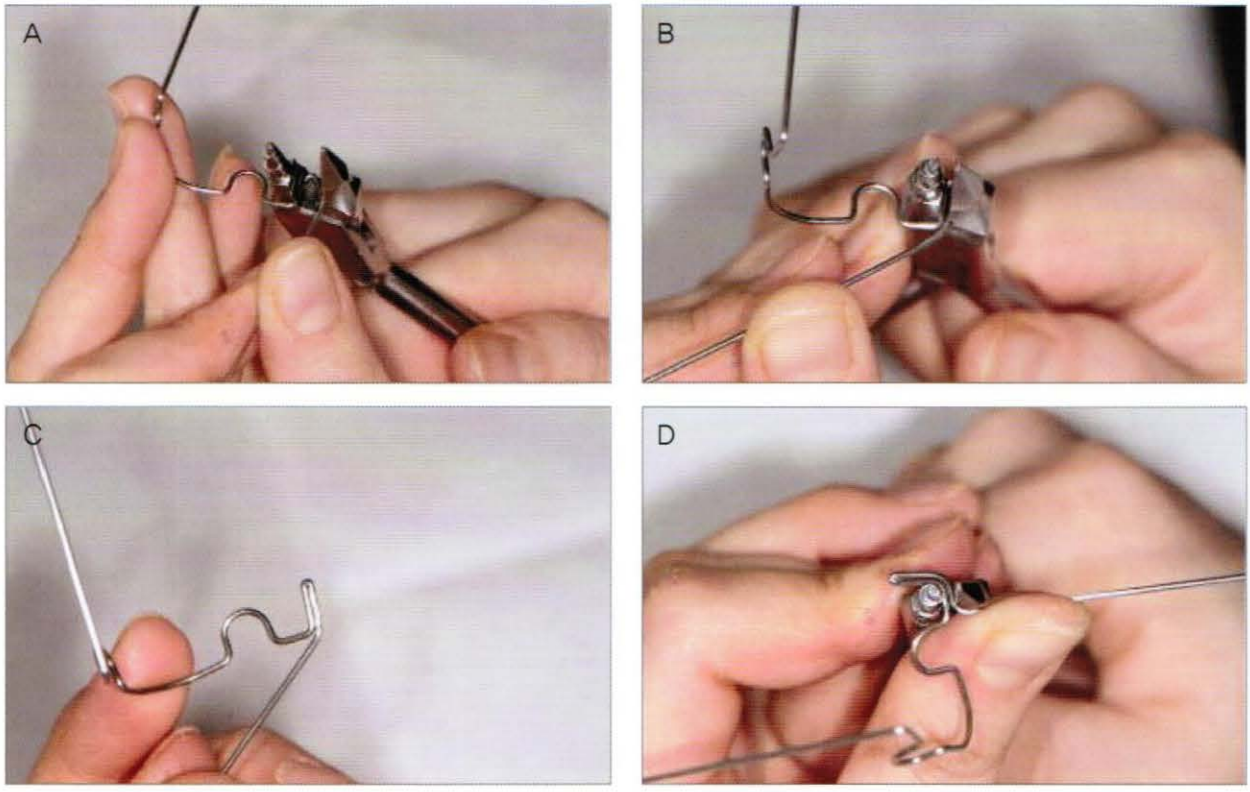


Figure 7-1-20. Bending of the retentive part which will insert into the palatal sheath
A, B. After squeezing, the right shape for palatal sheath insertion has been made.
C, D. Bend towards the TPA.

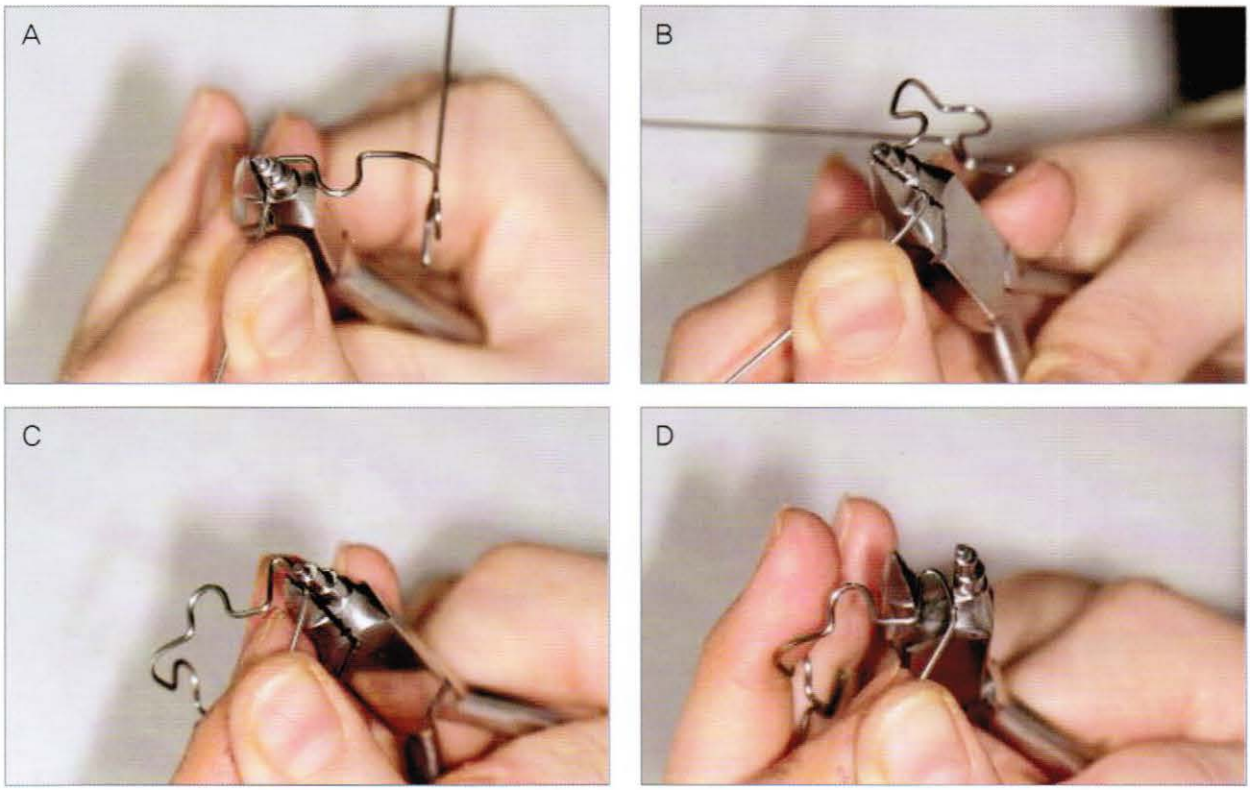


Figure 7-1-21. Construction of retentive part of the opposite side for insertion into the palatal sheath

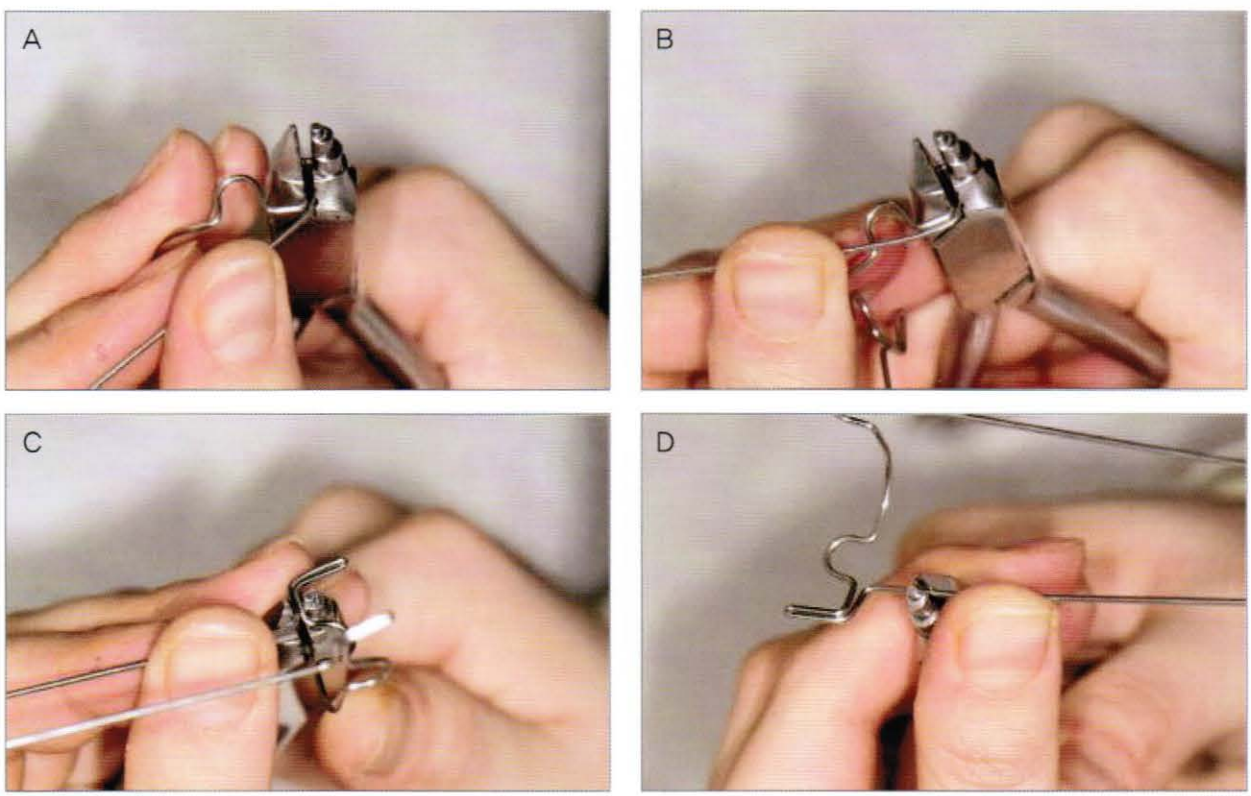


Figure 7-1-22. Construction of retentive part of the opposite side for insertion into the palatal sheath

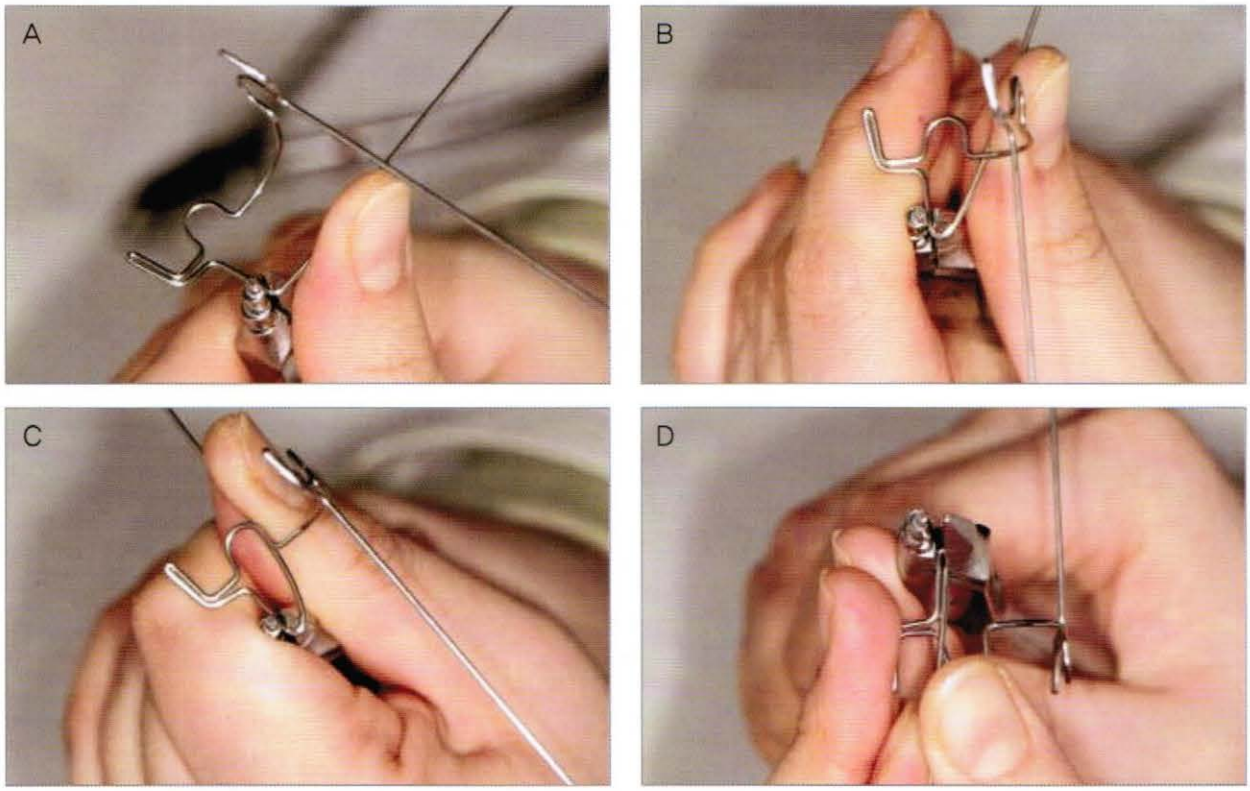


Figure 7-1-23. Construction of hook
S-shaped hook is made around the contact point between the canine and first premolar.

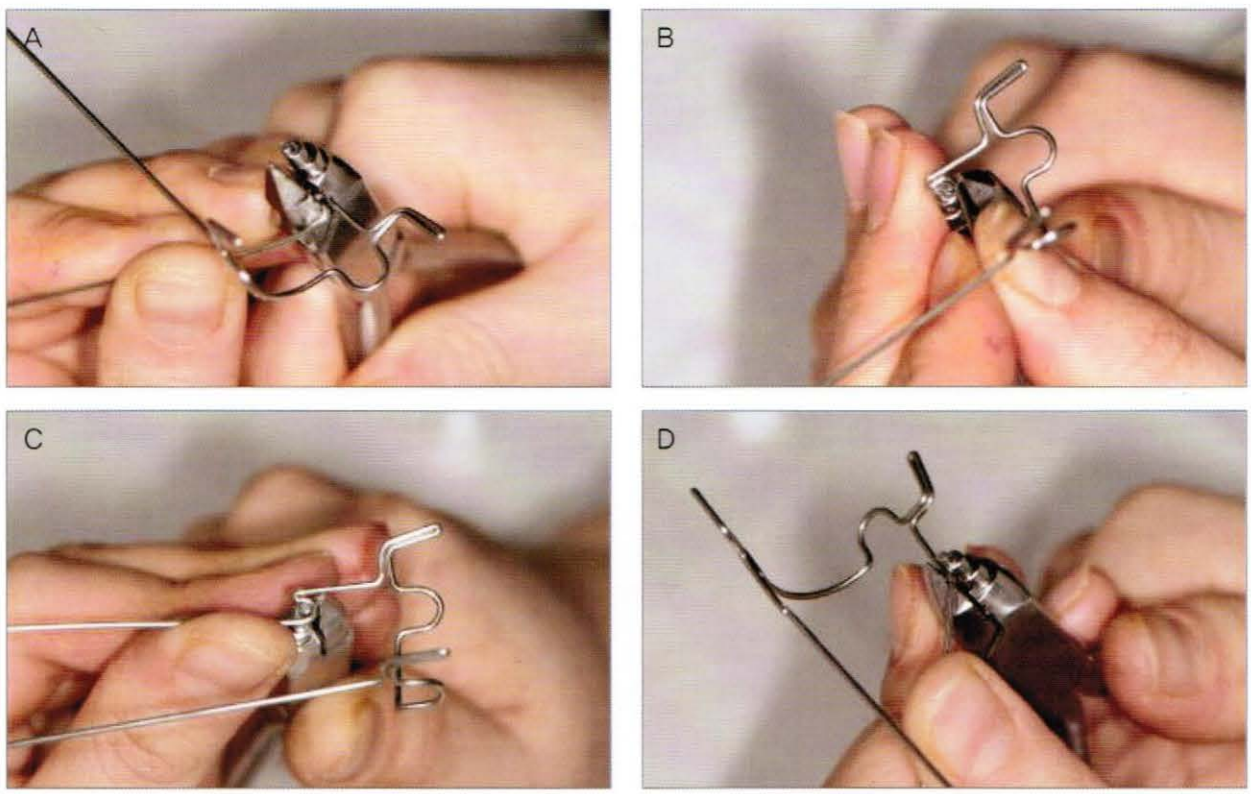


Figure 7-1-24. S-shaped hook
A, B, C. S-shaped hook is being constructed.
D. Adjust the SPA portion to sit around 0.5~1mm away from the palate.

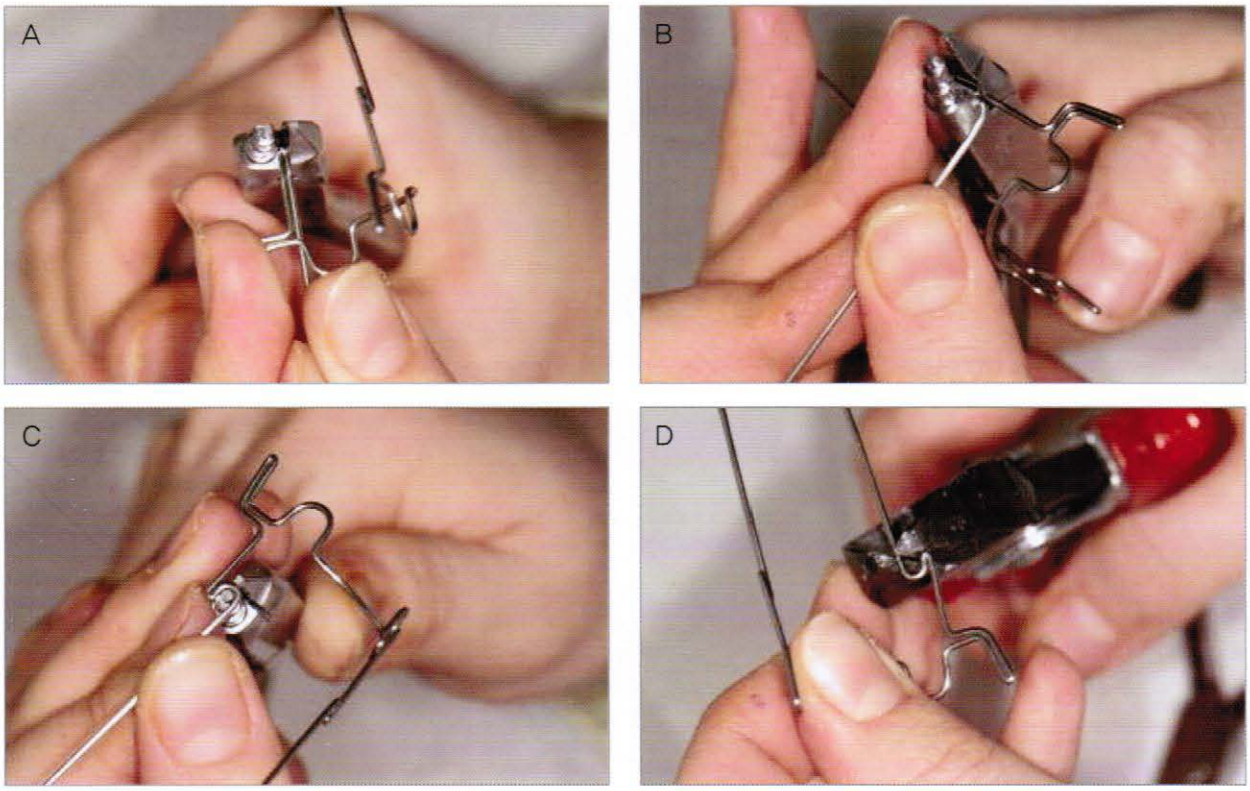


Figure 7-1-25. S-shaped hook on the other side
A, B, C. S-shaped hook is being made in the same way on the other side.
D. The remaining portion of the S-shaped hook is cut and polished.

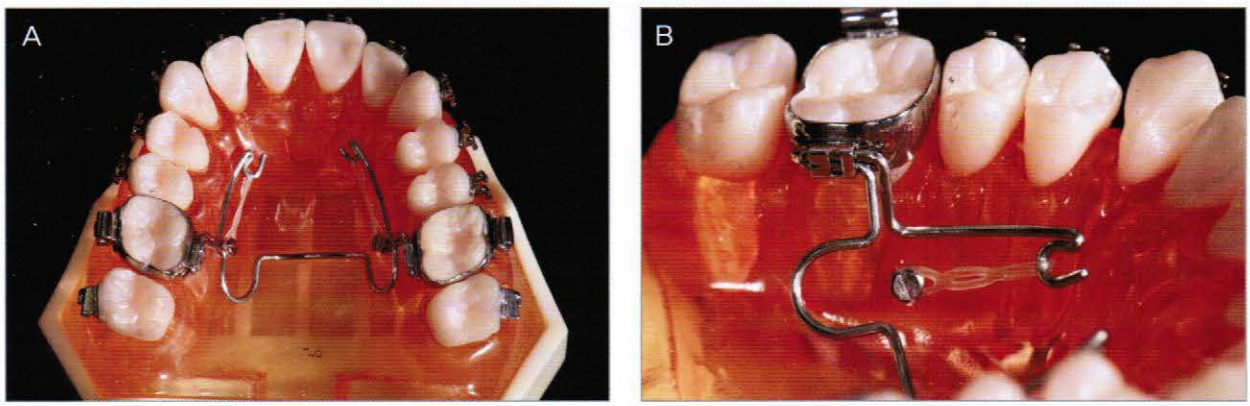


Figure 7-1-26. Completed TPA + SPA

Advantages

1) There is no rotation of the first molars as seen with Buccal SPA or Palatal SPA.

2) Width control of the molars is possible.

3) Both molars can be distalized at the same time.

Disadvantages

1) Manufacturing process is difficult.

2) There is increased discomfort for the patient.

Ⅱ. Biomechanics of SPA

1. Magnitude of applied force

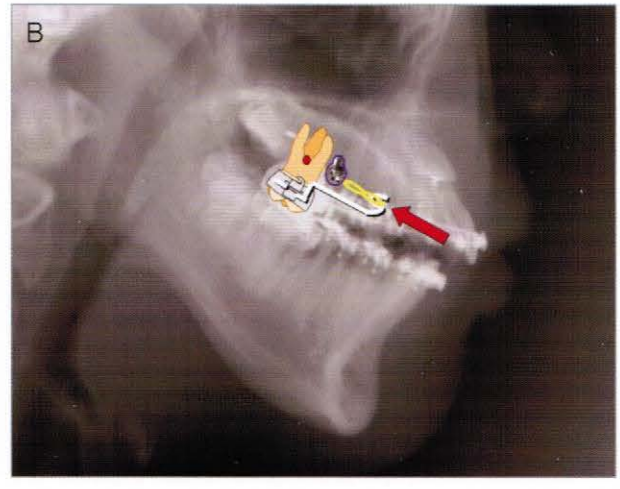
Bodily movement or translation occurs when SPA is used. The form of distal movement changes with changes in the vertical length of SPA. If the length between the retentive part of SPA to the hook increases, more root distal movement occurs, and if it is made shorter, more crown distal movement will occur.

According to Dr. Proffit (Table 7-2-1), 70gm of force is required for bodily movement of a single-rooted tooth and 120gm for a multi-rooted tooth. If distalization of upper first and second molars is planned, 240gm of force is appropriate.

Type of Movement	Force (gm)
Tipping	35–60
Bodily movement (translation)	70–120
Root uprighting	50–100
Rotation	35–60
Extrusion	35–60
Intrusion	10–20

Table 7-2-1. Amount of force required for different types of tooth movement
Cited from 'Contemporary Orthodontics' (2000) by W. R. Proffit

2. Possible mechanics for bodily movement



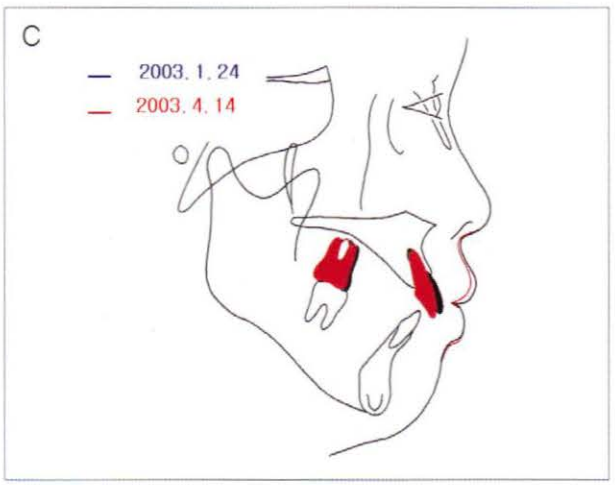
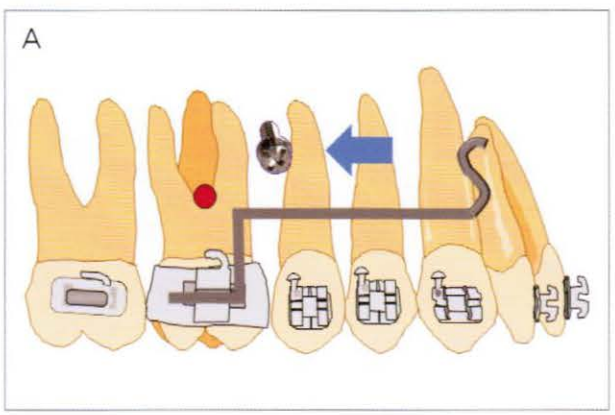


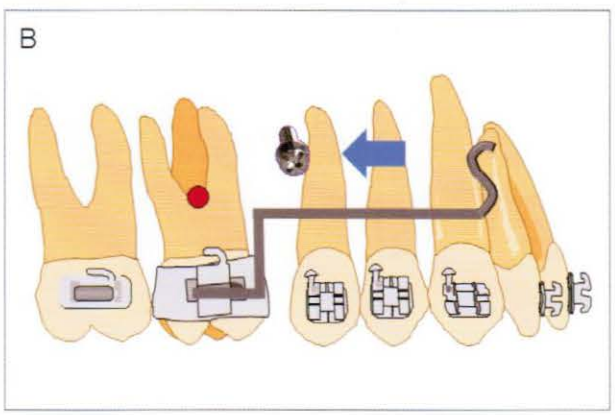
Figure 7-2-2. SPA force application and effect
A. Case where SPA was used. SPA can be seen on radiograph.
B. When force is applied in the direction of the arrow, this force passes through the center of resistance of the first molar. This will cause bodily movement.
C. Actual tooth movement which occurred in this case. There has been distal bodily movement. Also SPA can be used as anchorage for incisor retraction.

Each SPA has characteristics, advantages and disadvantages. The type of SPA can be chosen by considering the position of the mini-implant, but a more scrupulous consideration of the mechanics will bring better results.

3. Control of type of tooth movement

By controlling the vertical length of SPA, bodily movement, root distalization, and crown distal movement (tilting) is possible. When the SPA is longer vertically, there is more distal movement of the root (Figure 7-2-3A, B). When the SPA is shorter vertically, there is more distal tilting of the crown (Figure 7-2-3C, D).





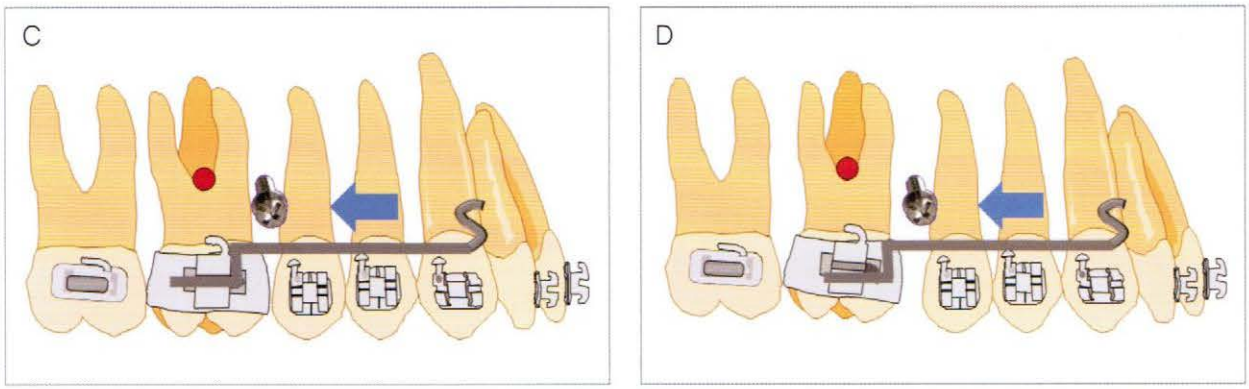


Figure 7-2-3. Difference in tooth movement according to vertical length of SPA
A, B. In picture A, the S-shaped hook sits higher than the tooth's center of resistance and so does the mini-implant. In this case, there is more distal movement of the root than the crown, as shown in Picture B.
C, D. In picture C, the S-shaped hook sits lower than the tooth's center of resistance and so does the mini-implant. In this case, there is more distal movement of the crown than the root, as shown in Picture D.

Clinical tip ››››

What are the reasons for controlling crown and root movement during SPA use?

If the crown is tipped distally, it brings better results for rapid arch expansion. With root movement distally, crown distalization is slower. However when Class II molar relationship is corrected this way, the potential for relapse is higher.

4. Tooth rotation due to SPA use

Differences in tooth rotation can occur according to whether Buccal SPA or Palatal SPA is used. Figure 7-2-4A shows rotation which occurs with Palatal SPA, and Figure 7-2-4B shows rotation with Buccal SPA.

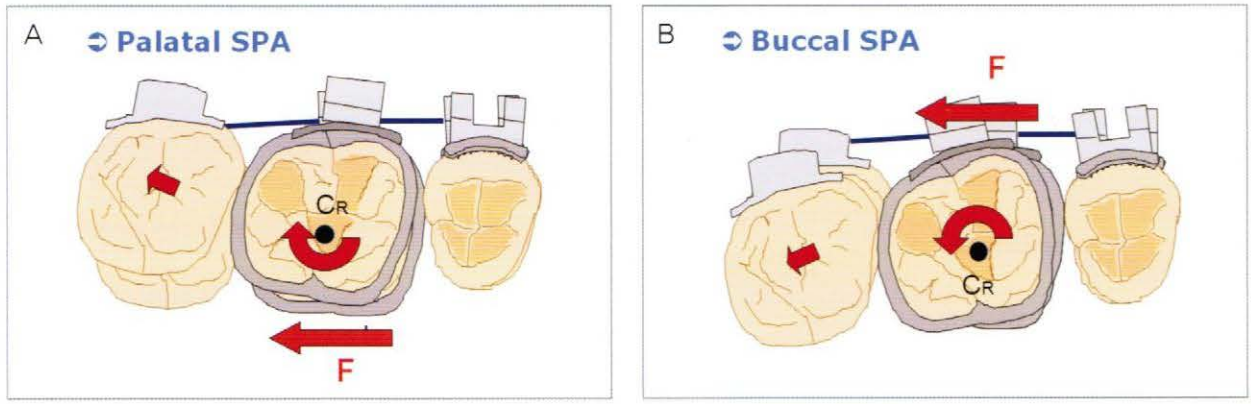


Figure 7-2-4. Rotation and side-effects with Palatal SPA and Buccal SPA
A. Palatal SPA. Looking from the occlusal surface, clockwise rotation can occur, and the second molar can be pushed out buccally.
B. Buccal SPA. Looking from the occlusal surface, anti-clockwise rotation can occur, and the second molar can be pulled in palatally.

There are 3 methods of preventing these side-effects. 1) A thick wire (usually 018x022" ss) is used. 2) Buccal SPA and Palatal SPA are used together. 3) TPA + SPA is used. Small distal movements (up to 1~2mm) do not cause big problems, but any more distalization needs one or more of the prevention measures stated above.

5. Doesn't the mini-implant contact the distal root of the second premolar?

If the second premolar is pulled distally into the space obtained from first molar distalization, it would seem that the second premolar root would touch the mini-implant. This is a question received often from clinicians (Figure 7-2-5). Regular periapical radiographs must be taken during retraction of the second premolar. However clinically, 3~4mm of distalization is possible without any problems (Figure 7-2-6). The reasoning for this is that the center of rotation of the second premolar is at a similar level to the mini-implant. Therefore during distalization of the crown, there is little movement at the center of rotation of the root. This mechanism is explained in Figure 7-2-6.

SPA is suitable for 3~4mm of distalization. However if more tooth movement is required without the second premolar contacting the mini-implant, the following methods can be used. 1) Insert the mini-implant as close to the first molar as possible. 2) After distalization of the first molar, the mini-implant is re-inserted more distally.

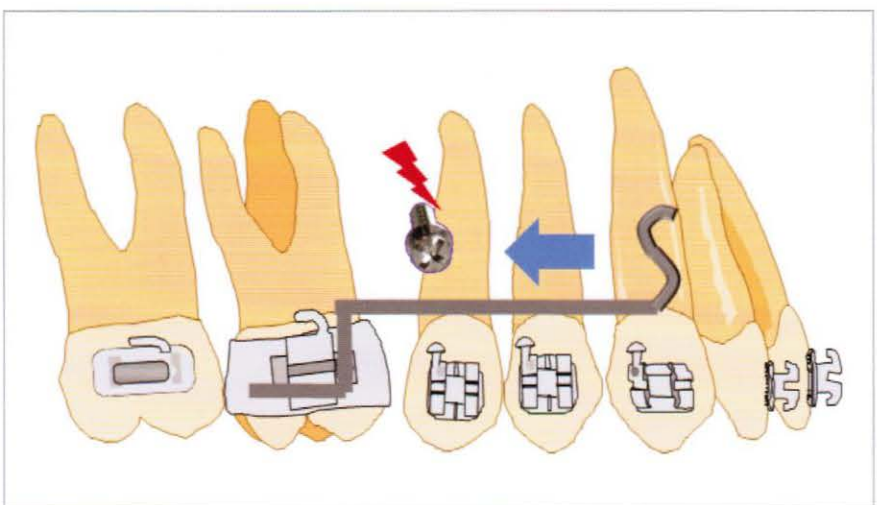


Figure 7-2-5. After molar distalization with SPA, and during retraction of the anterior teeth, the distal surface of the second premolar can contact the mini-implant. Regular periapical radiographs should be taken.

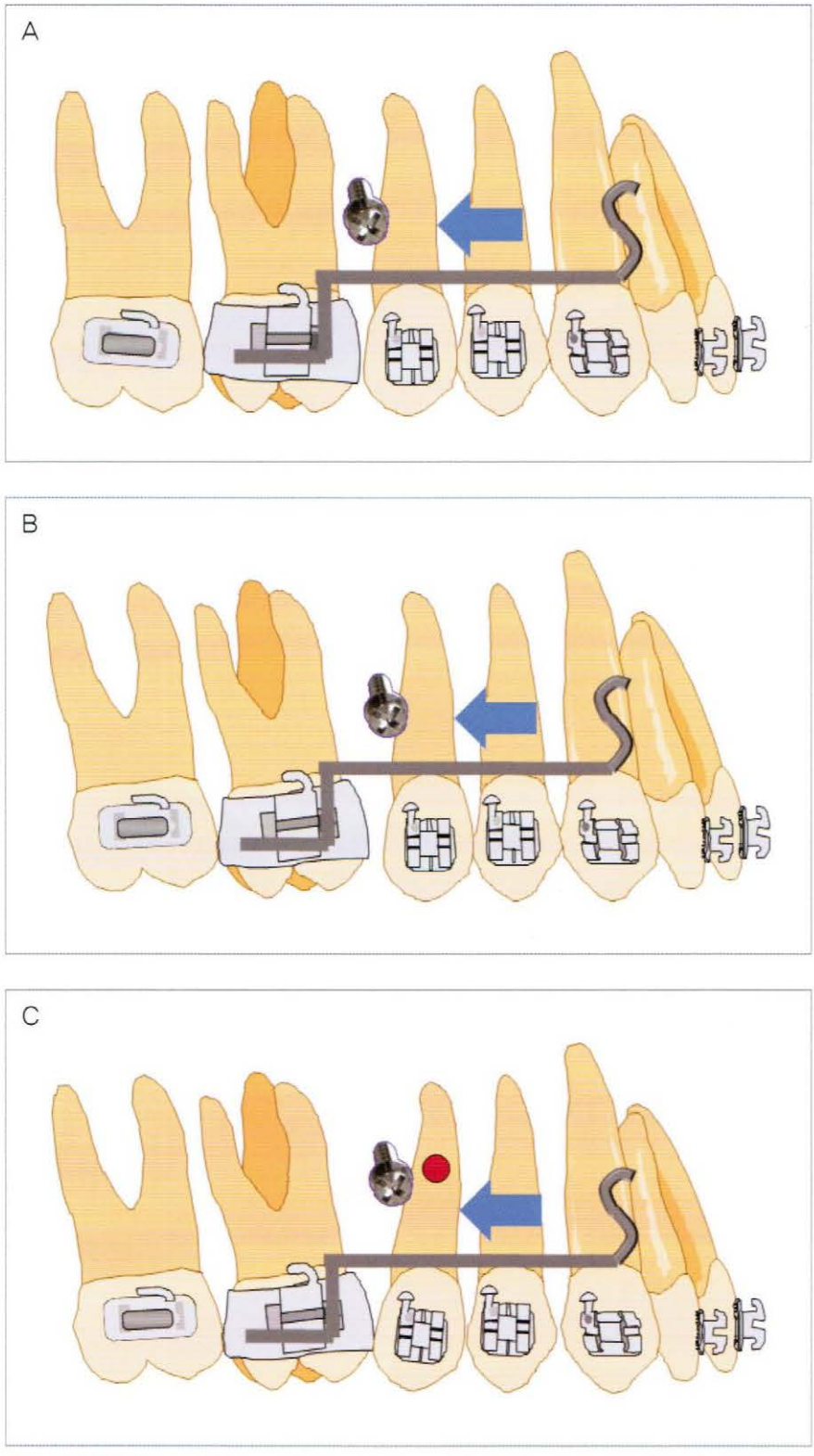


Figure 7-2-6. Buccal SPA is suitable for 3~4mm of distalization. Because the second premolar center of rotation is at a height similar to the mini-implant, actual tooth movement at the root's center of rotation is minor.

A. Commencement of molar distalization after fitting of SPA.

B. First and second molars have been distalized. Space has formed from distal movement.

C. Second premolar and anterior teeth are moved distally into the space obtained from molar distalization. Distal tipping of the second premolar allows space closure without root contact. However regular periapical radiographs should be taken to observe whether root contact has occurred.

Ⅲ. Clinical applications of SPA

SPA can be used instead of cervical headgear for molar distalization. It is especially useful when only one first molar is to be distalized. Because buccal mini-implants between the first premolar and first molar is widely used, SPA can be applied without difficulty.

■ Case 12 (Figure 7-3-1 to 28)

- Age : 14 years 8 months
- Sex : female
- Chief complaint: impaction of several molars (upper molars and lower second molar on her right side)
- Special features : although she showed other problems such as facial asymmetry, occlusal plane canting and mouth protrusion, the patient did not show interest in treating these problems. She especially refused extraction treatment for mouth protrusion.

Figure 7-3-1. Pre-treatment facial photographs of Case 12 (2002. 12.27)
The chief complaint of the patient and parents is multiple upper and lower molar impaction.
A. With generalized growth retardation of the right side, facial asymmetry is evident.
B. Upper midline is leaning toward the right. There is occlusal plane canting with the right side turned up.
C, D. Mouth is protruded.

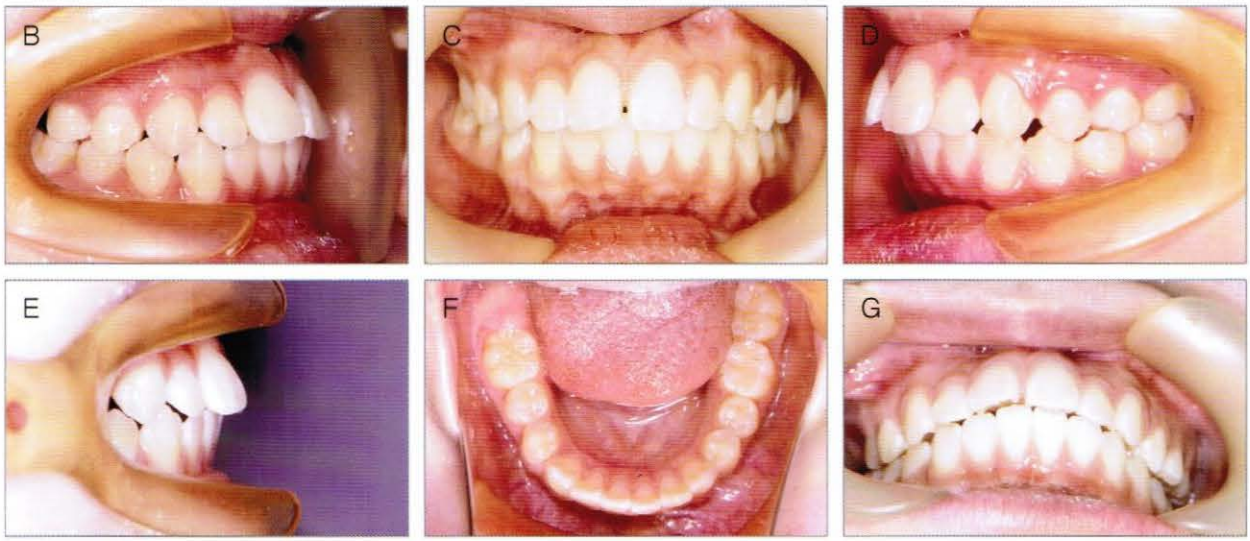


Figure 7-3-2. Pre-treatment intraoral photographs of Case 12 (2002. 12.27)
There is impaction of both upper and lower molars (A, F). Right canine and first molars show Class I relationship (B). Left canine and first molars show Class II relationship. There is an upper midline shift to the right with median diastema (C).

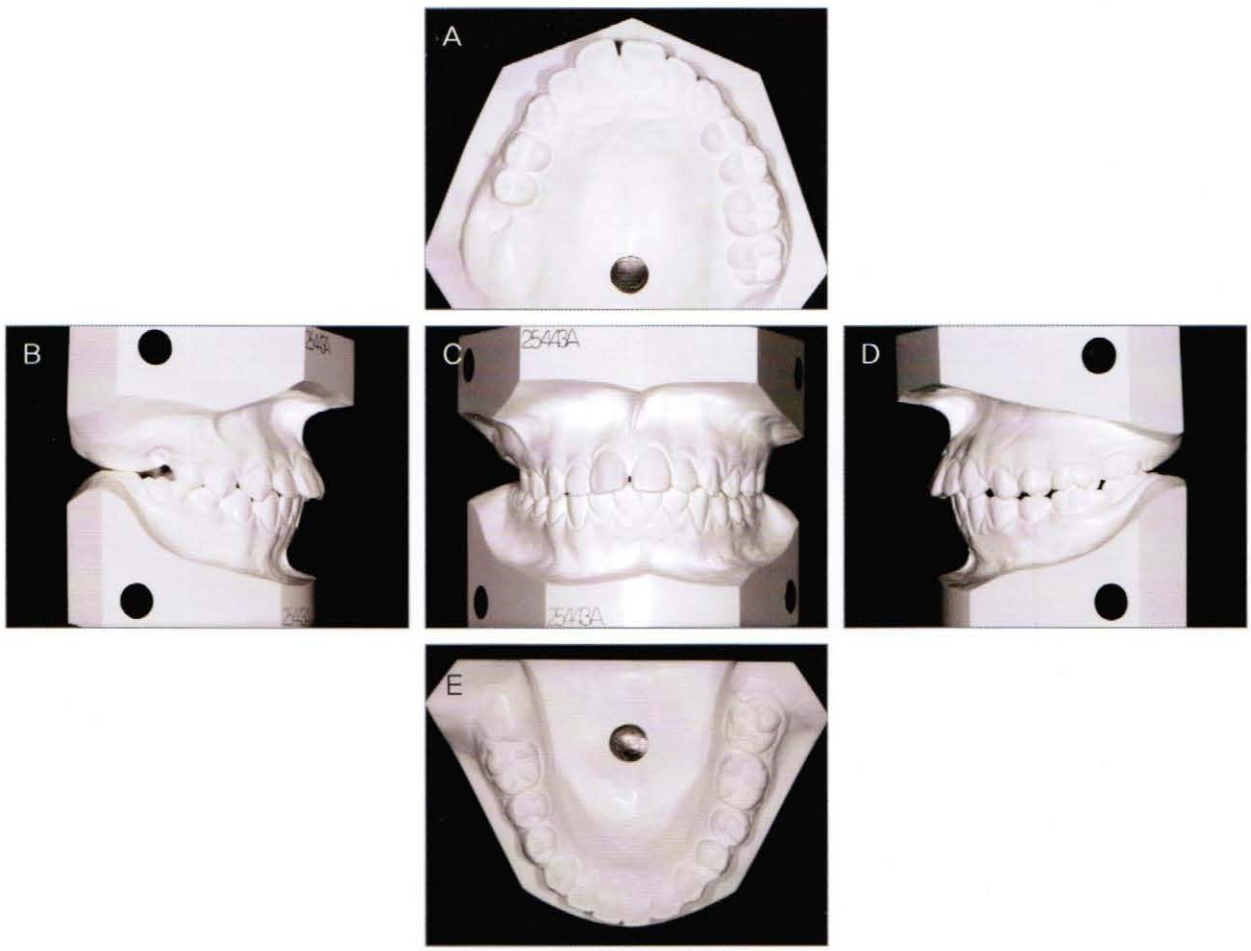
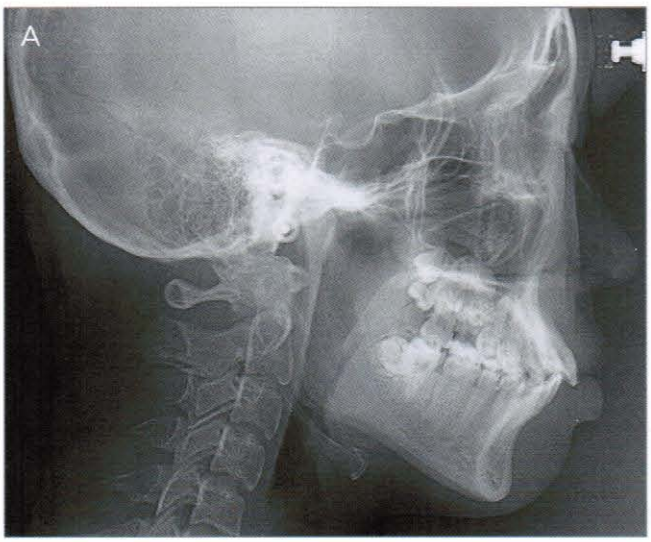
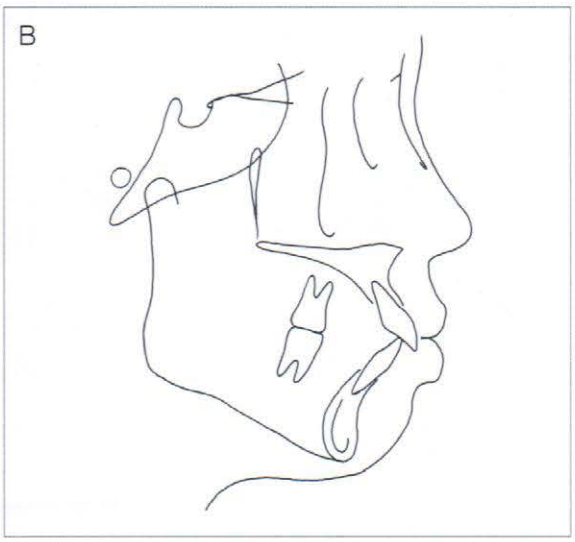


Figure 7-3-3. Pre-treatment study models of Case 12 (2002. 12.27)
Left first molar shows Class II relationship. Upper teeth have tilted into the impacted right molar space, causing upper midline shift to the right.





C

	Norm	SD	T1
SNA	81.6	3.2	75.0
SNB	79.2	3.0	71.4
ANB	2.5	1.8	3.6
FMA	24.3	4.6	26.2
ODI	72.2	5.5	78.1
U1 to FH	116.0	5.8	121.4
IMPA	95.9	6.4	103.7
IIA	123.8	8.3	109.0
Esth-U	-0.9	2.2	1.6
Esth-L	0.56	2.3	4.3

Figure 7-3-4. Pre-treatment cephalometric radiograph (A), tracing (B) and measurement (C) (2002. 12.27)
A. Slight mandible undergrowth is seen.
B, C. Antero-posterior skeletal pattern can be said to be Class II. Both upper and lower molars are labially inclined.

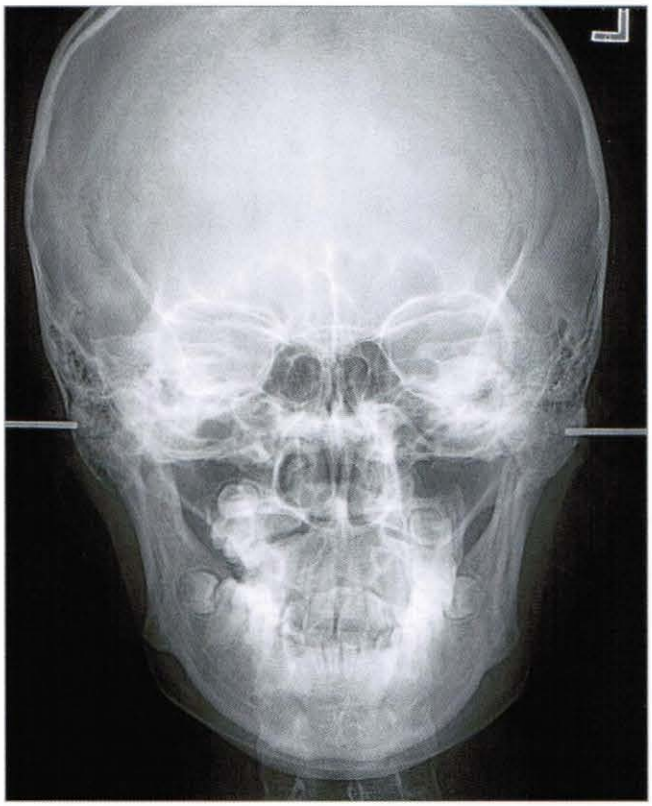


Figure 7-3-5. Pre-treatment postero-anterior radiograph
Skeletal asymmetry is present with inclination of the upper central incisor to the right, and the midline is also shifted to the right.

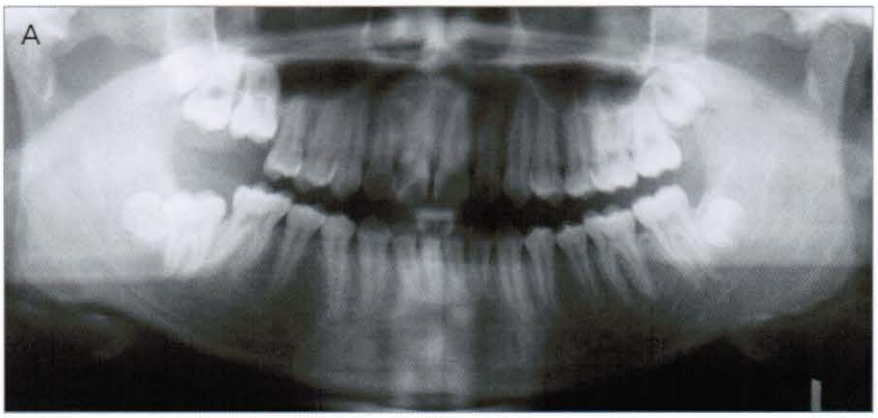
Clinical tip ››››

Multiple upper and lower molar impaction cases - syndrome?

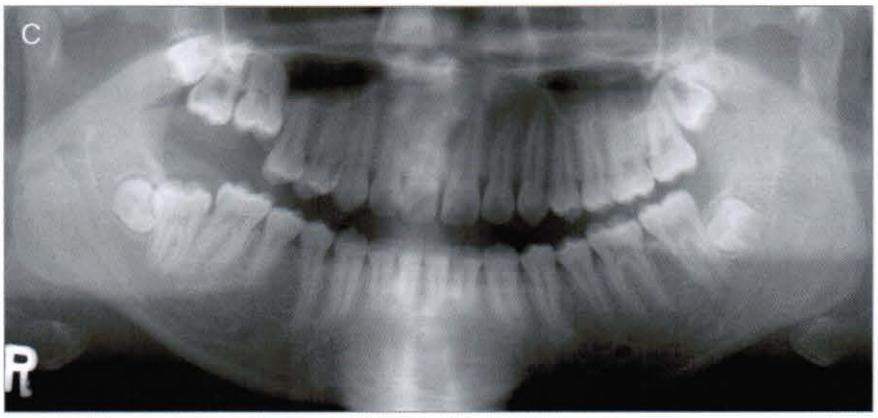
Cases such as Case 12, with multiple impaction of molars on one side are not as rare as imagined. In these cases, jaw growth is retarded, with muscle and soft tissues also thinner than the opposite side. Often one or two teeth are ankylosed and show no movement with force application. This has not been reported as being a syndrome.

First, force can be applied after window opening. Or wait after window opening for natural eruption as attempted in Case 12. It must be explained to the patient that extraction is a possibility.

The tooth did not erupt at all prior to window opening (Figure 7-3-6). Thick fibrous tissue was thought to be the cause of eruption difficulty. The second molar erupted after window opening. Therefore in such cases where thick fibrous tissue lies over the impacted tooth, exposure of the tooth should first be attempted to observe for natural eruption.


A

B


C
R

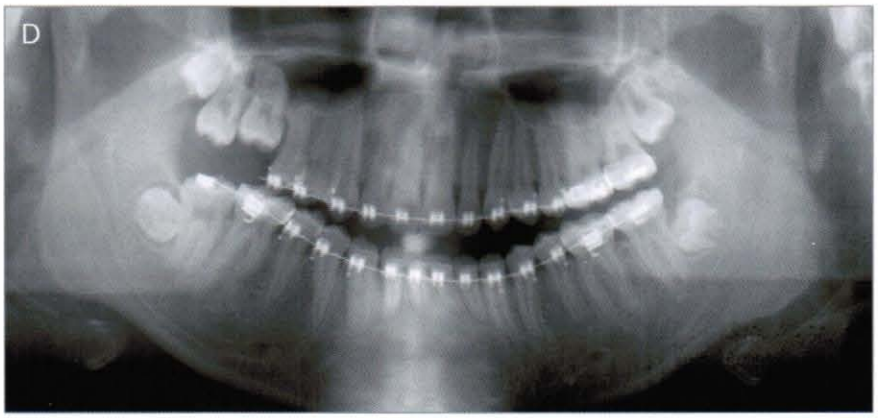

D

Figure 7-3-6. Pre-treatment and early panoramic radiograph
A. First radiograph taken at a private clinic (2002. 7.10)
B. Second radiograph taken at the same private clinic (2002. 12.9)
The patient was referred to SNUDH after the impacted molars showed no changes.
C. Seven months after first visit to SNUDH (2003. 7.30)
There is no movement of the impacted molars compared to 1 year ago. Removal of overlying fibrous tissue and window opening was decided (2003. 8.30)
D. One year after window opening, upper and lower second molars erupted. With no movement of the upper first molar, it was diagnosed as being ankylosed, and referred for extraction (2004.6.30). The lower second molar had erupted spontaneously but was leaning distally. Tube was bonded for leveling.

Treatment Progress

▪ Observation — 23 months

– 2002. 7.10	First visit to a private orthodontic clinic
– 2002. 12.9	Referred from a private clinic
– 2002. 12.27	Taking of Initial records
– 2003. 7.30	Panoramic radiograph. No erupting movement of #16, 17 & 47
– 2003. 8.10	Window opening of #16, 17 & 47

▪ Leveling — 2 months

– 2004. 6.30	Spontaneous eruption of #17 & 47 was observed. Refer for extraction of # 16 Full bonding of lower teeth & 014″ NiTi
– 2004. 7.21	U : 014″ NiTi L : 016″ NiTi
– 2004. 8.11	U : 016″ NiTi L : 018″ NiTi
– 2004. 9.1	U : 018″ NiTi L : 016×022″ NiTi

▪ Traction of # 17 — 27 months

– 2004. 9.22	U : 016×022″ NiTi + TPA with hooks for alignment of #17
– 2004. 11.25	U : 018×022″ ss with a T-loop for mesial traction of #17 L : 018×025″ ss
– 2005. 1.19	Implantation 1.6×6.0 1EA $\underline{3\downarrow 2}$
– 2005. 4.13	U/L : 018×022″ ss with shoe hooks + NiTi closed coil spring for #17 traction
– 2005. 9.16	Implantation 1.6×6.0 1EA $\underline{5\downarrow 6}$ + Buccal SPA for distal driving of #26 & 27
– 2005. 5.3	L : 019×025″ TMA + Control of #46
– 2006. 12.15	Removal of mini-implants, Finished traction of #17

▪ Detailing — 3 months

▪ Debonding
– 2007. 3.22

Active treatment time ; 32 months

The antero-posterior skeletal pattern in this case is said to be Class II. Both upper and lower incisors show labioversion. Because the interincisal angle is small and the mouth protruded, extraction treatment would be the treatment of choice. However the parents refused any extraction and only wanted treatment of the impacted molars. With the radiograph taken at the private clinic (2002.7.10, Figure 7-3-6B) as reference, regular panoramic radiographs (2002.12.9, Figure 7-3-6B) were taken, but even 1 year later, no specific eruption signs were seen (2003.8.10, Figure 7-3-6C). First, removal of the overlying fibrous tissue covering the occlusal surface of the impacted molar was referred to the Periodontics Department. Eruption is at last observed 11 months after window opening (2004.6.30, Figure 7-3-6D). But the upper right molar was extracted after considering it ankylosed. Severe dilaceration of the disto-buccal root was thought to be the cause. Leveling was commenced with the exception of the impacted upper right second molar (2004.6.30, Figure 7-3-6D). TPA was inserted, with a hook soldered for traction of the impacted second molar towards the palate (2004.9.22, Figure 7-3-7A).

Upper right second molar was protracted forward into the space of the extracted first molar, but treatment took a long time. The reason for the longer space closure period was thought to be due to pneumatization of the maxillary sinus (Figure 7-3-14).

The patient's left canine and molar relationship was Class II, but it was improved to a Class I after 2~3mm of distalization from use of Buccal SPA. SPA is effective for distalization of molars on one side as shown in this case.

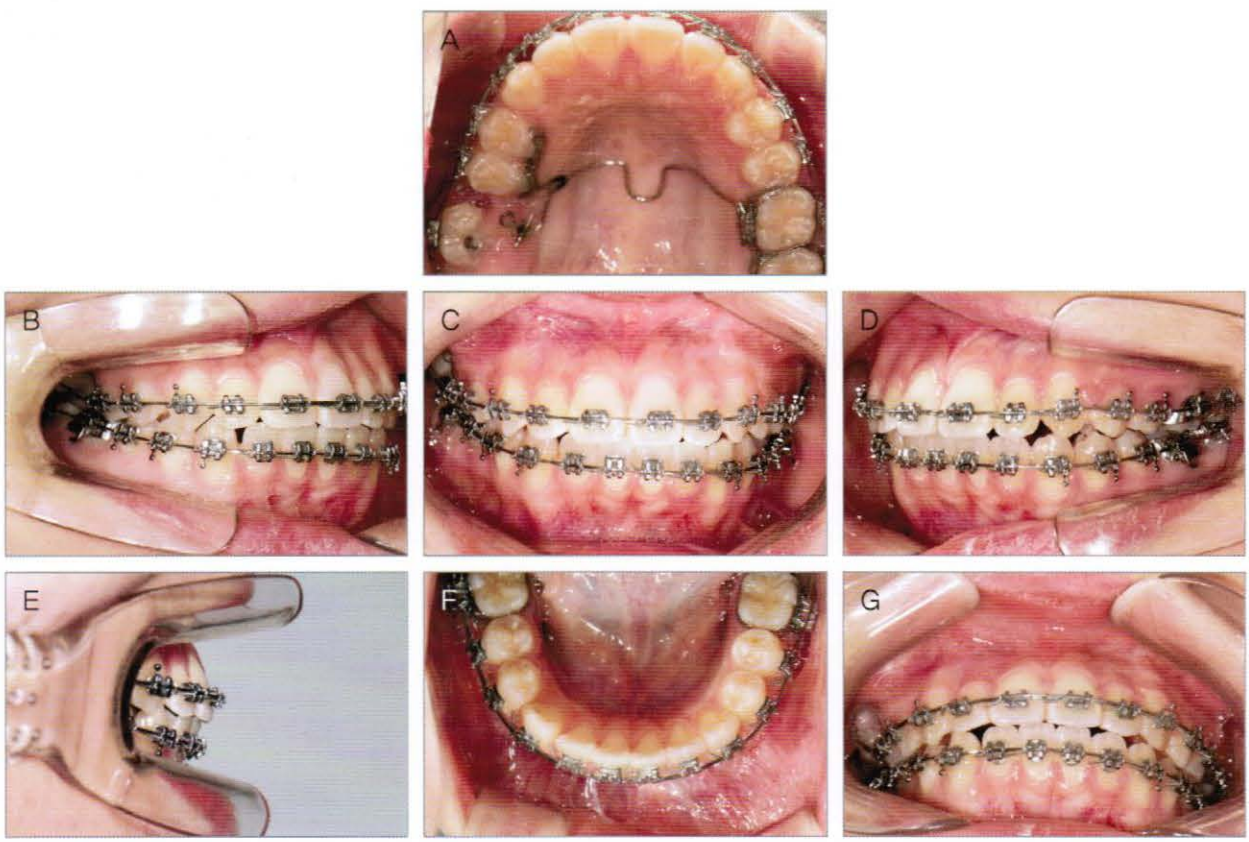


Figure 7-3-7. After leveling of the upper and lower dentition, the impacted upper second molar is being moved to the level of the occlusal plane (2004. 9.22)

A. TPA has been inserted after slight modification. On the left first molar, the TPA was inserted into the palatal sheath, and on the right, TPA was bonded with resin onto the first and second premolars. A hook has been soldered onto the TPA for traction of the impacted second molar towards the occlusal surface.

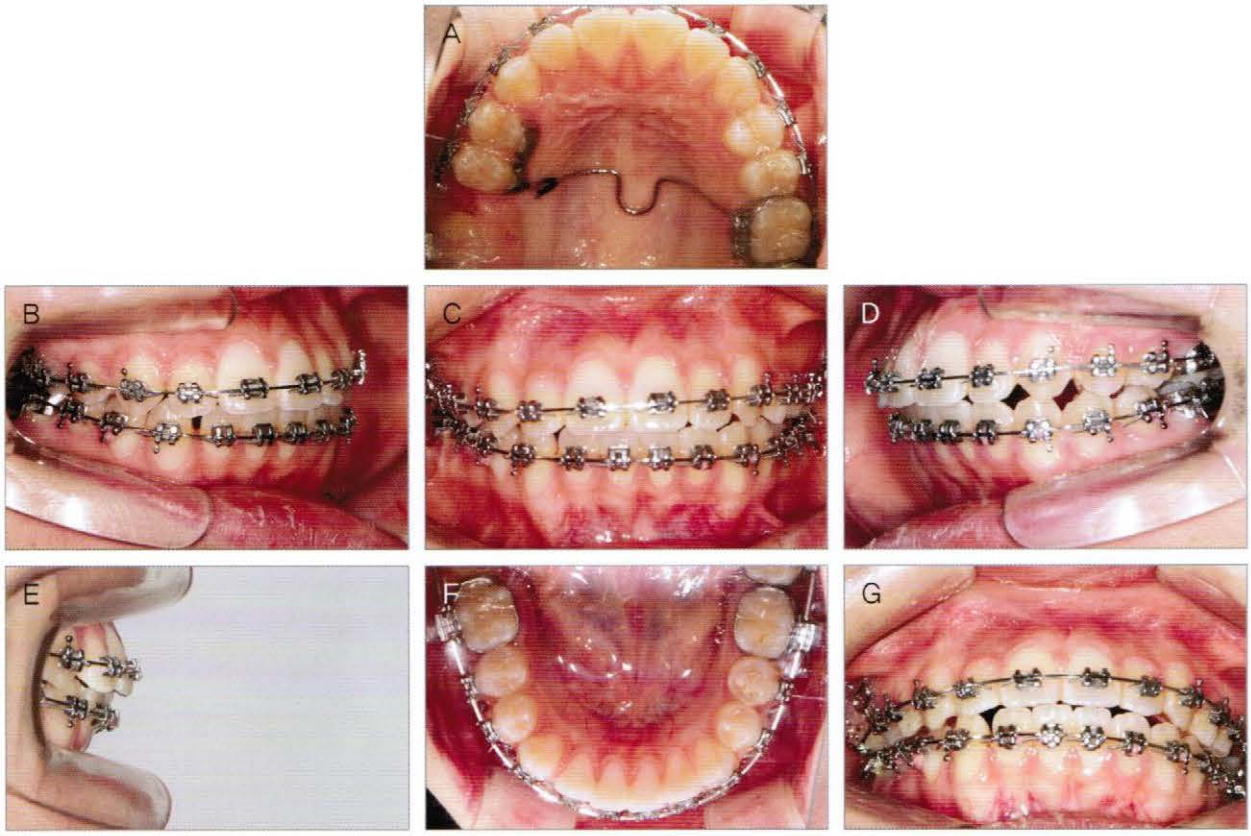


Figure 7-3-8. Mesial traction of the upper second molar (2004. 11.25)
The impacted upper second molar has been extruded a little more towards the occlusal surface. A 018×022″ ss with T-loop wire is being used for mesial movement. The lower arch is also ligated with 018×022″ ss with shoe hooks (Figure 7-3-9). With commencement of mesial movement of the upper right second molar using T-loop, the upper midline will be deviated further. To prevent this, 1) a thick upper archwire and 2) TPA were used.

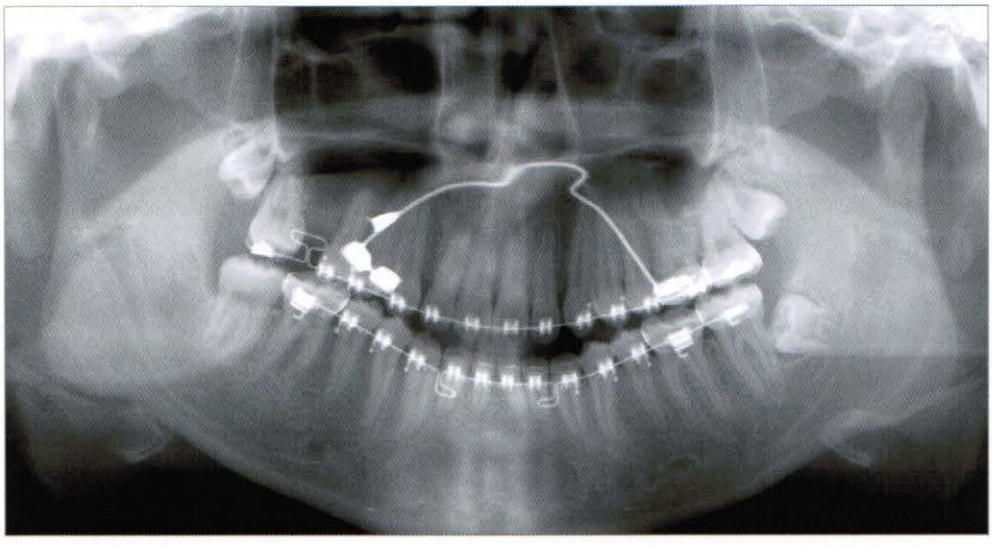


Figure 7-3-9. Panoramic radiograph after mesial protraction of upper right second molar (2005. 1.19)
T-loop mesial to the upper right molar can be seen. The interradicular space between the upper right lateral incisor and canine is sufficient for mini-implant insertion. A 1.6×6.0mm mini-implant was inserted in this area labially.

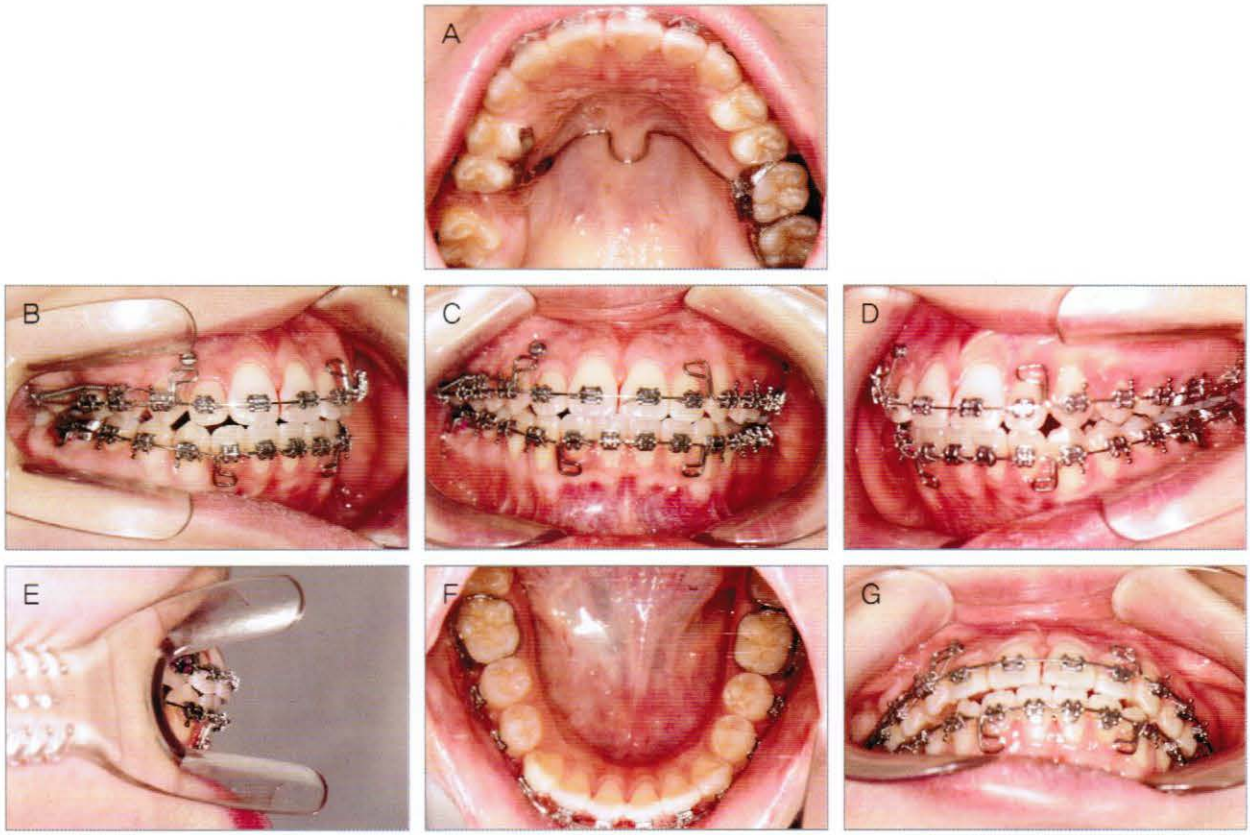


Figure 7-3-10. Upper right second molar traction after reinforcement of anterior anchorage through mini-implant (2005. 4.13)
Mini-implant head and upper right canine has been tightly ligated with ligature wire (B, C). NiTi closed coil spring is being used for protraction of the second molar. Upper midline is shifted to the right and the left canine and molar relationship is Class III.

Figure 7-3-11. Periapical radiograph for insertion of mini-implant between the upper left second premolar and first molar, for Buccal SPA use (2005. 10.21)
Space between roots is sufficient. 1.6×6.0mm mini-implant was inserted.

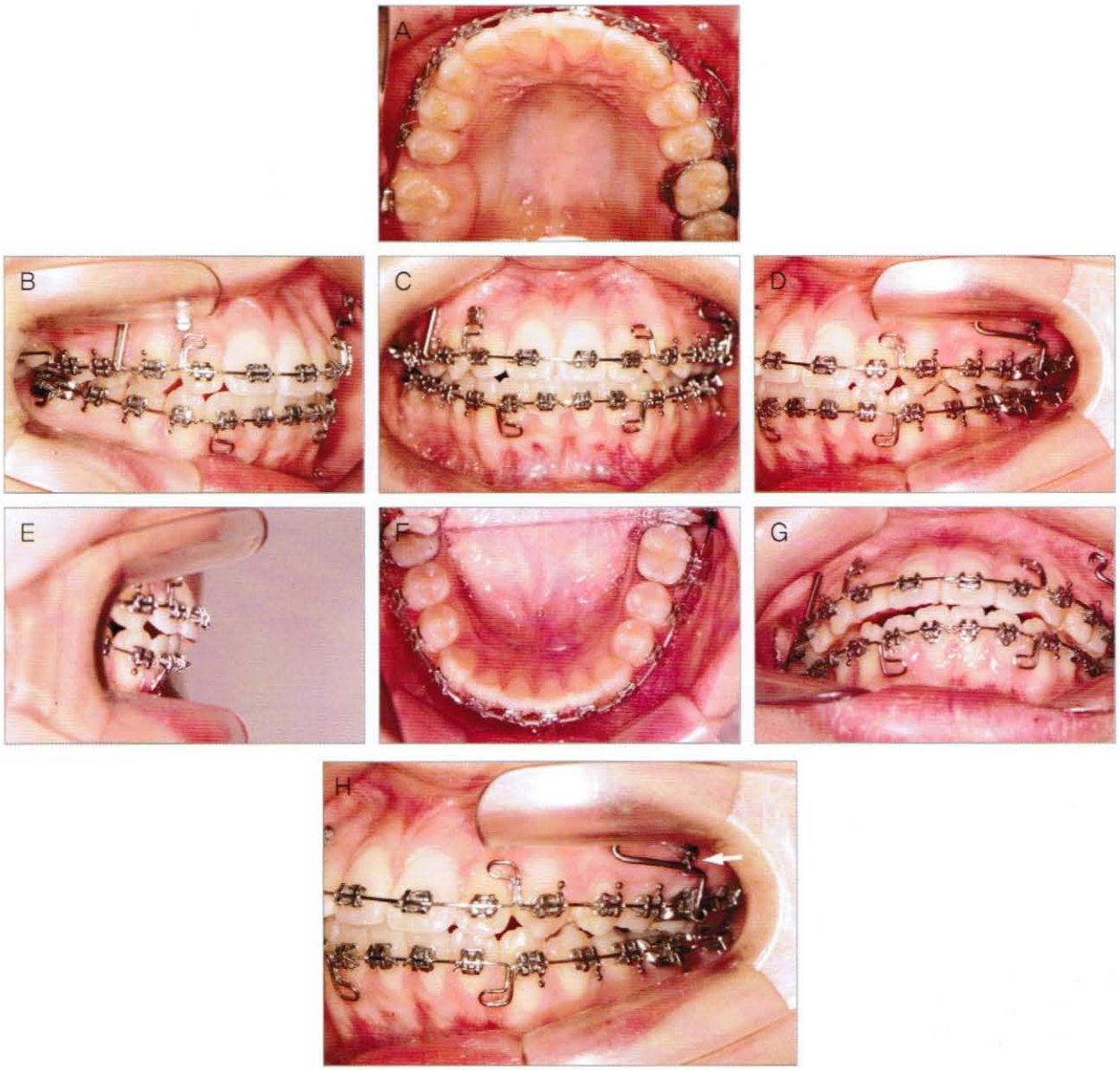


Figure 7-3-12. Buccal SPA and distalization of upper right second molar (2005. 10.21)
It has been 5 weeks since beginning use of Buccal SPA (D). Small space has formed distal to the upper left canine. With distalization of molars, spacing between anterior teeth has occurred (A). TPA has been removed for distalization of the upper left molar. A step was placed in the archwire distal to the upper right second premolar (B). This step has been included because occlusion with the lower molar can obstruct mesial movement of the upper second molar.

Clinical tip ››››

Buccal TPA keeps moving. What are some methods for fixation?

Compared to the Palatal SPA, because Buccal SPA is inserted into the headgear tube as a round wire, it does not sit at a fixed position and rotates. For prevention, SPA and mini-implant is ligated together (Figure 7-3-12H, arrow).

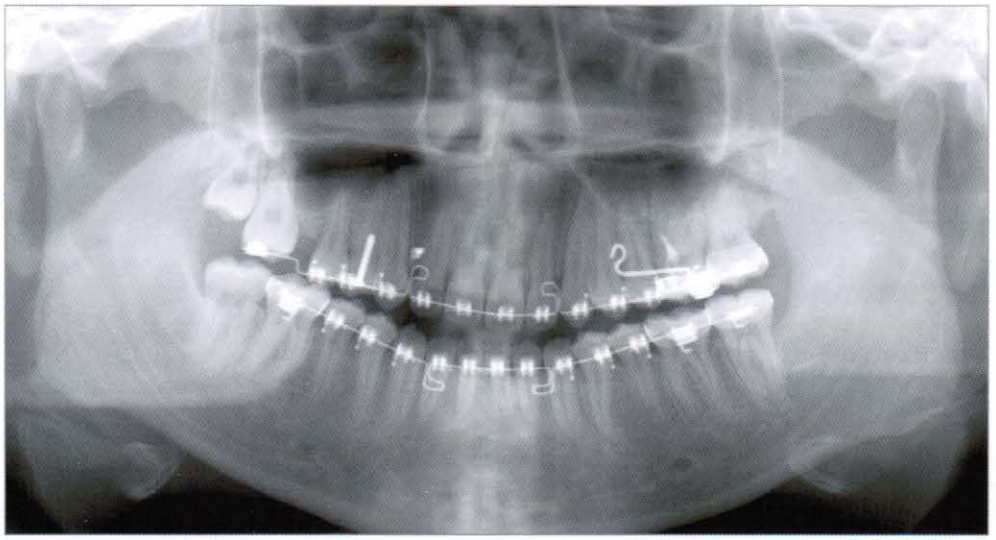


Figure 7-3-13. Three months into distalization of upper first molar (2006. 1.25)
Regular radiographs are taken to check whether the distal surface of the upper right second premolar root and mini-implant make contact. There is pneumatization between the upper right second molar and second premolar. A periapical radiograph of this area was taken (Figure 7-3-14).

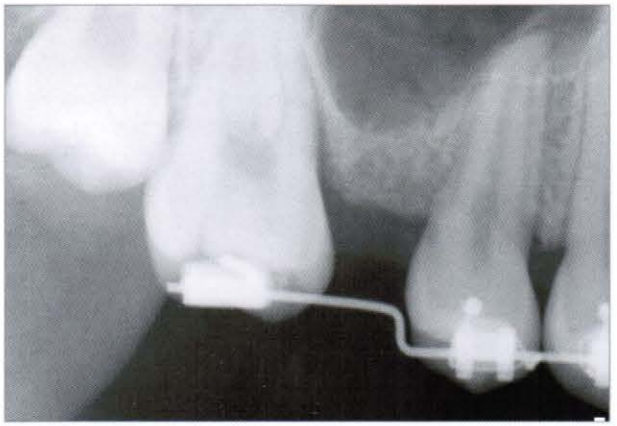


Figure 7-3-14. Periapical radiograph of upper right second molar and second premolar (2006. 1.25)
There is pneumatization of the maxillary sinus.

Clinical tip ››››

Is space closure possible when there is pneumatization of the maxillary sinus?

Yes. But rate of tooth movement is very slow. This case took 27 months. This is because for mesial movement of the second molar, continued bone apposition must occur on the inner surface of the maxillary sinus, and resorption on the root side.

The patient and parents must be made aware of this fact to obtain good compliance over the long treatment period.

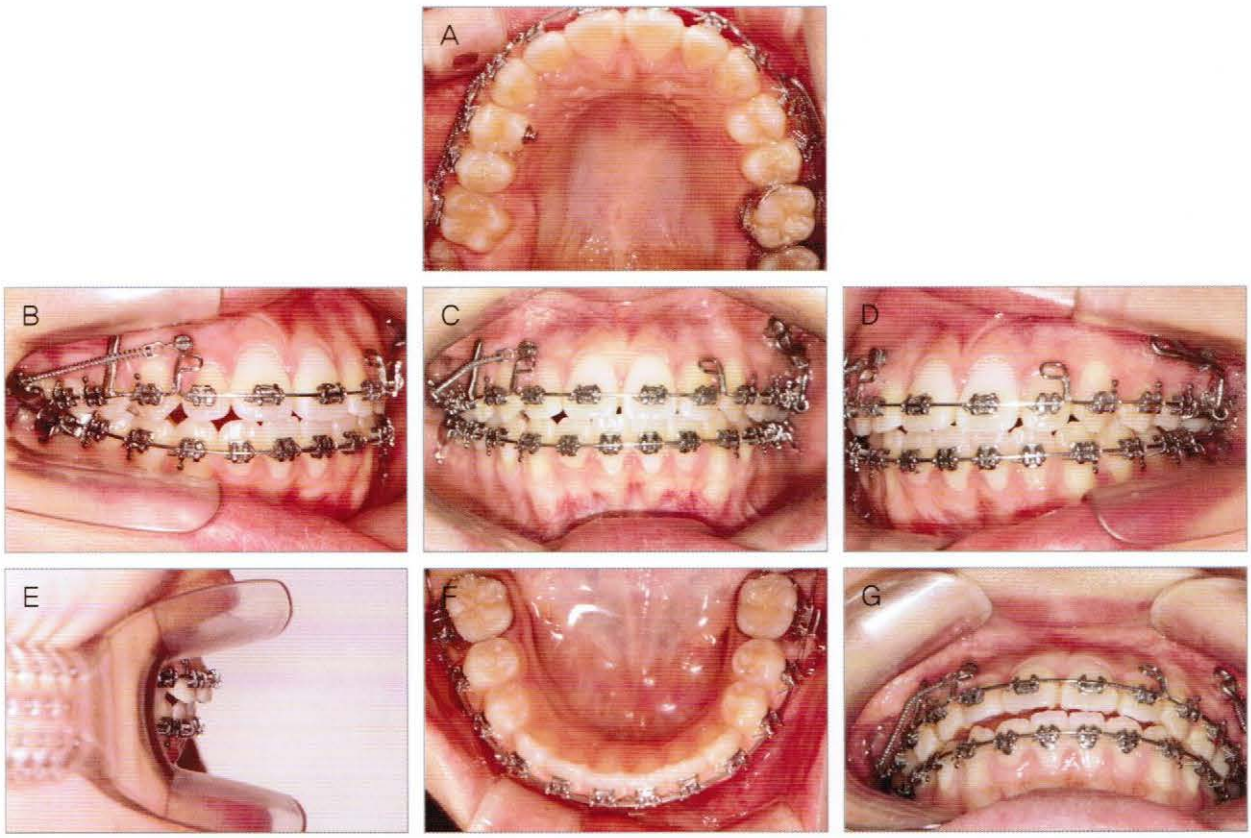


Figure 7-3-15. Intraoral photographs after space closure of upper right first molar space (2006. 8.4)
The extraction space has been closed through mesial movement of the upper right second molar (A). The third molar is visible behind the second molar (A). The midline is still deviated quite a lot. Detailing is being carried out in the lower arch using 019×025" TMA wire. The vertical level of the lower right first molar and bucco-lingual tilting is being corrected (B).

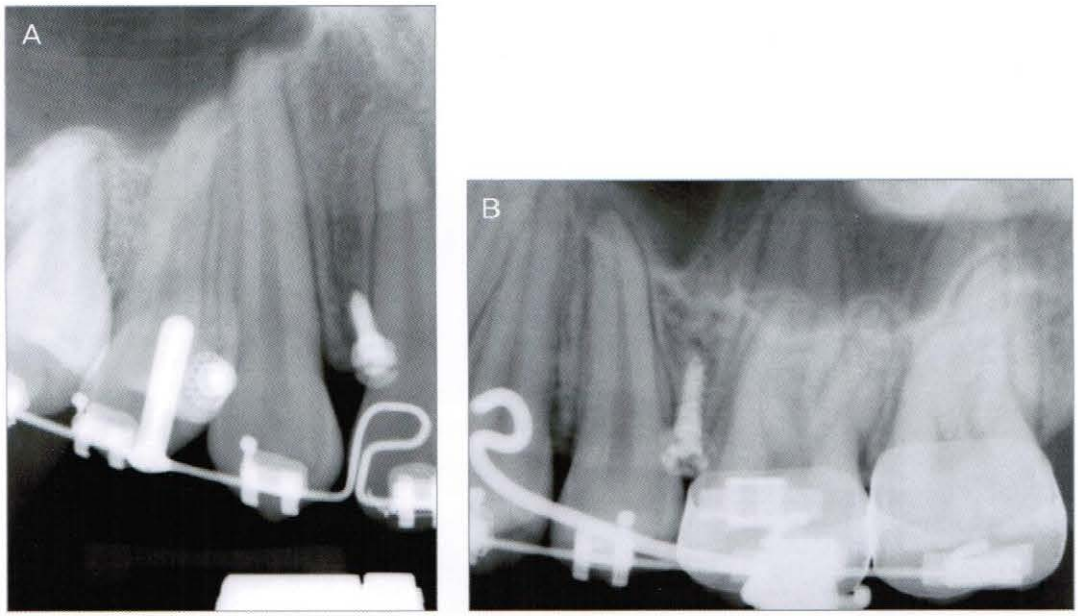


Figure 7-3-16. Periapical radiograph to check for root contact between the mini-implant and root (2006. 8.4)
SPA and mini-implant was used for a while longer to improve the upper midline. These were removed after 4 months (2006. 12.15).

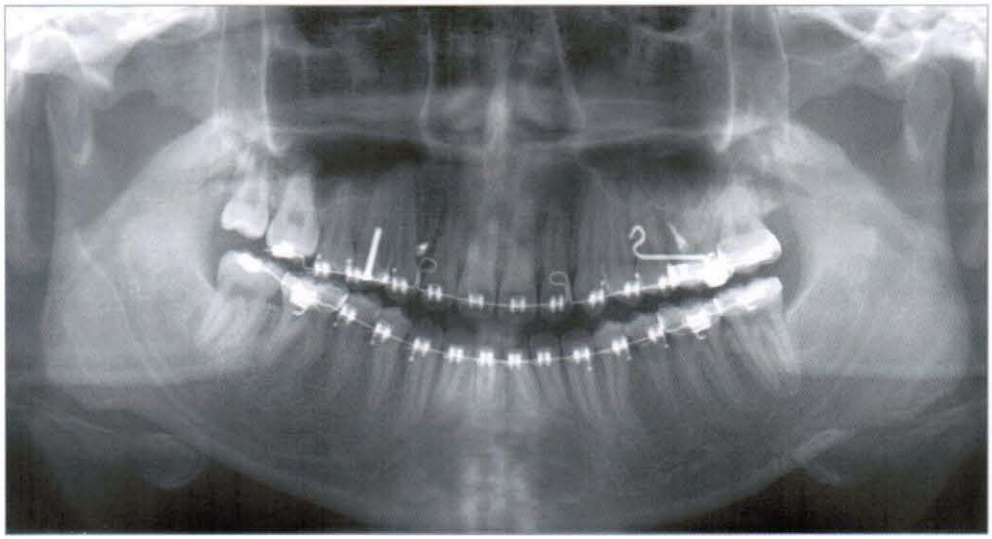


Figure 7-3-17. Panoramic radiograph taken at the detailing stage to check root parallelism (2006. 11.17)
The positions of the upper right second molar and third molar roots are adequate.

Clinical tip ››››

Characteristics of molar distalization through SPA

Not only crown tipping, but bodily movement occurs (if the SPA hook is closer to the tooth apex, more root distalization occurs).

Because bodily movement occurs, distalization is slow. If crown tipping is required, move the level of the hook towards the cervical area, or use a jig.

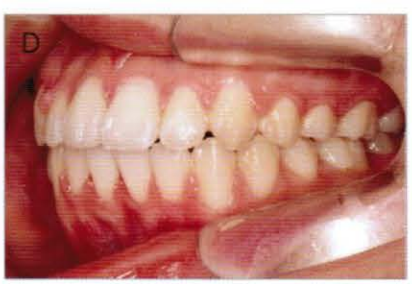


Figure 7-3-18. Intraoral photograph at debonding (2007. 3.22)
The upper and lower midline is coincident, and left and right canine and molars are in Class I relationship. The impacted upper right second molar has moved well into the space of the extracted first molar.

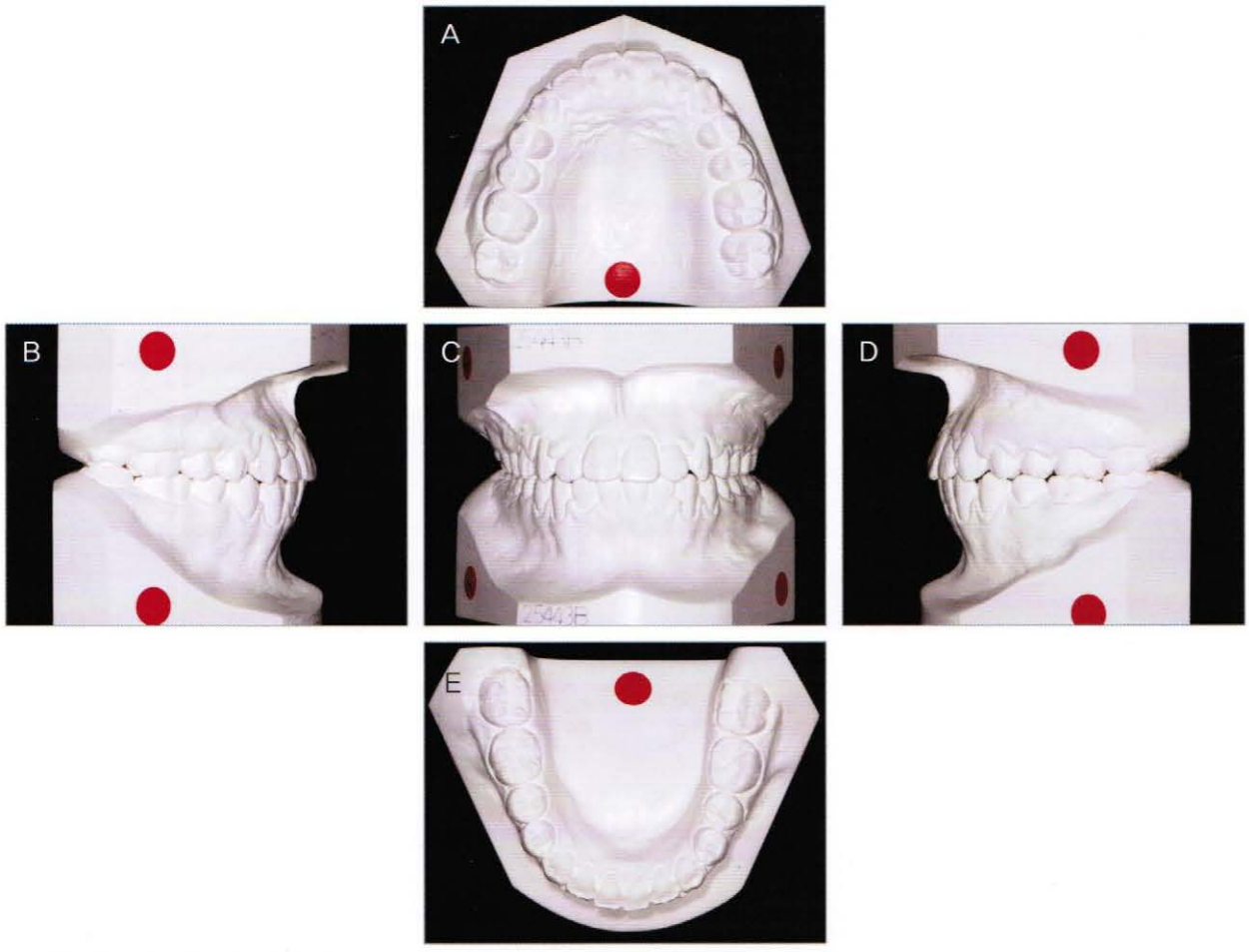


Figure 7-3-19. Post-treatment study model of Case 12
The upper right third molar has also erupted well into occlusion.

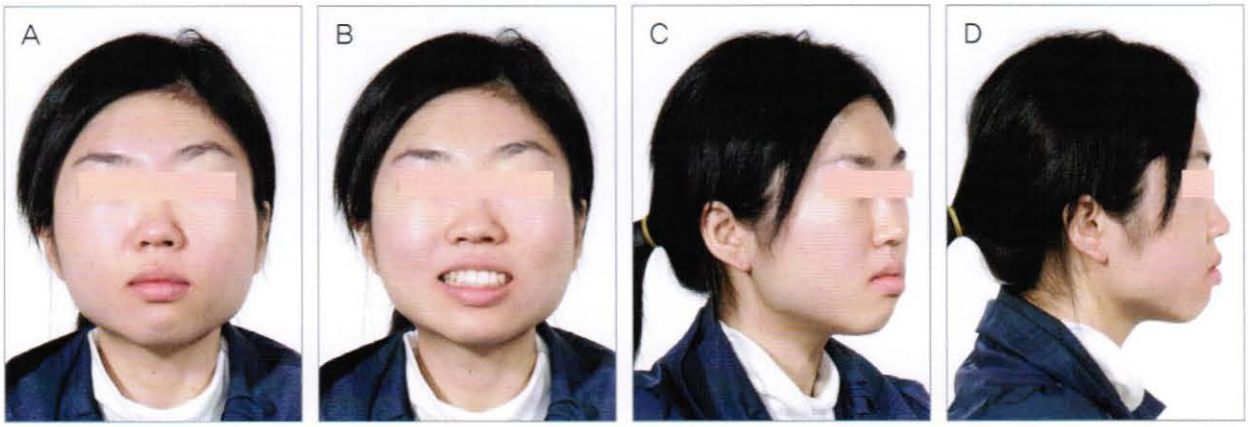
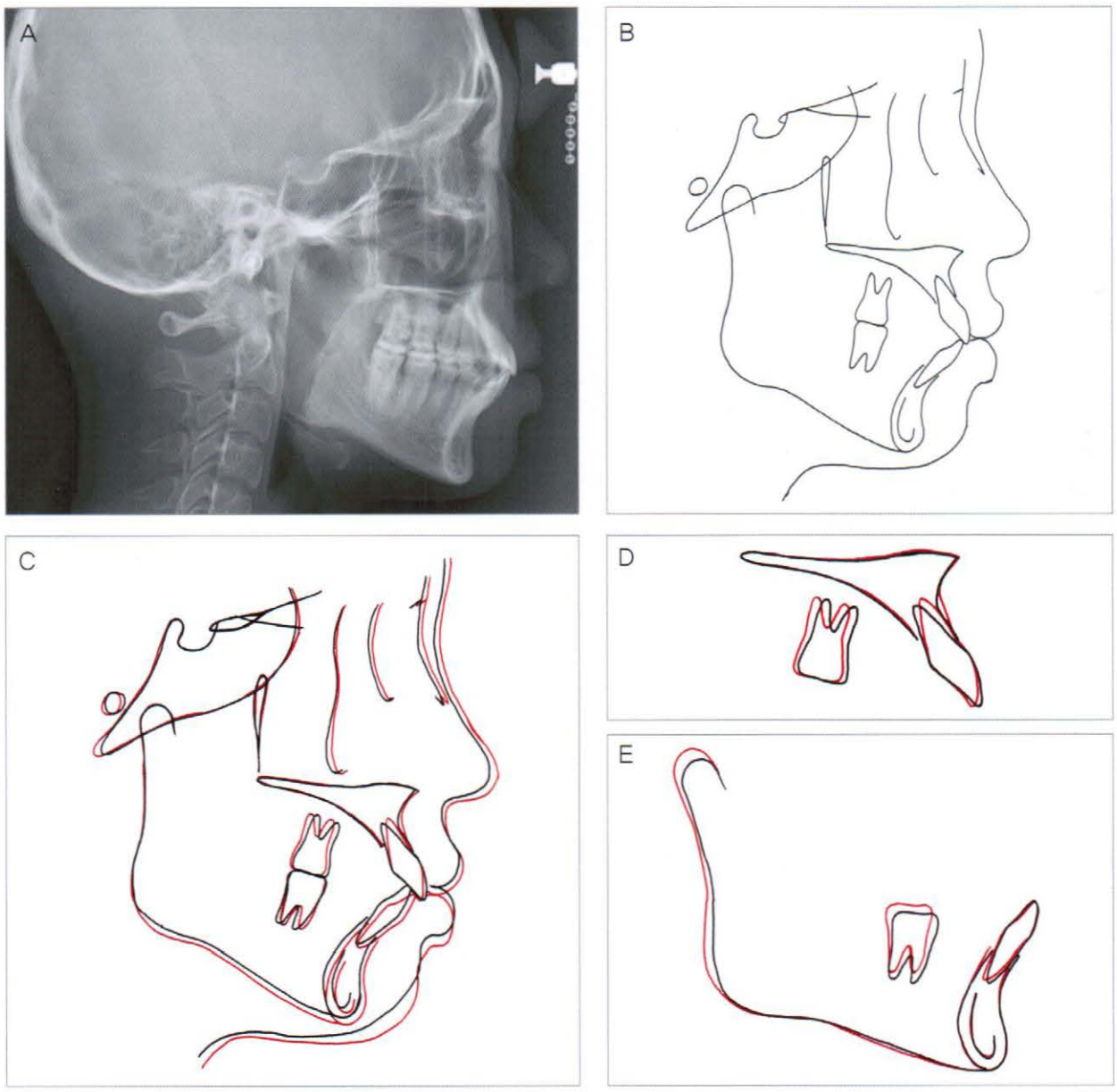


Figure 7-3-20. Facial photograph at debonding (2007. 3.22)
There are no particular changes in the face. The patient was very pleased with the treatment results.



F

	Norm	SD	T1	T2
SNA	81.6	3.2	75.0	73.4
SNB	79.2	3.0	71.4	70.9
ANB	2.5	1.8	3.6	2.5
FMA	24.3	4.6	26.2	26.3
ODI	72.2	5.5	78.1	78.0
U1 to FH	116.0	5.8	121.4	112.3
IMPA	95.9	6.4	103.7	108.3
IIA	123.8	8.3	109.0	113.1
Esth-U	-0.9	2.2	1.6	-0.1
Esth-L	0.6	2.3	4.3	1.6

Figure 7-3-21. Cephalometric radiograph and measurement at debonding (2007. 3.22)
A. Post-treatment cephalometric radiograph
B. Post-treatment cephalometric tracing
C. Pre- and post-treatment superimposition. Favorable growth has helped the nose look higher, and the profile has improved with mandible growth. Mouth protrusion looks better.
D. Superimposition of maxilla. The upper left first molar has been traced. Around 2mm of distal bodily movement has occurred with the Buccal SPA.
E. Superimposition of mandible.
F. T1 is pre-treatment, T2 is after debonding.

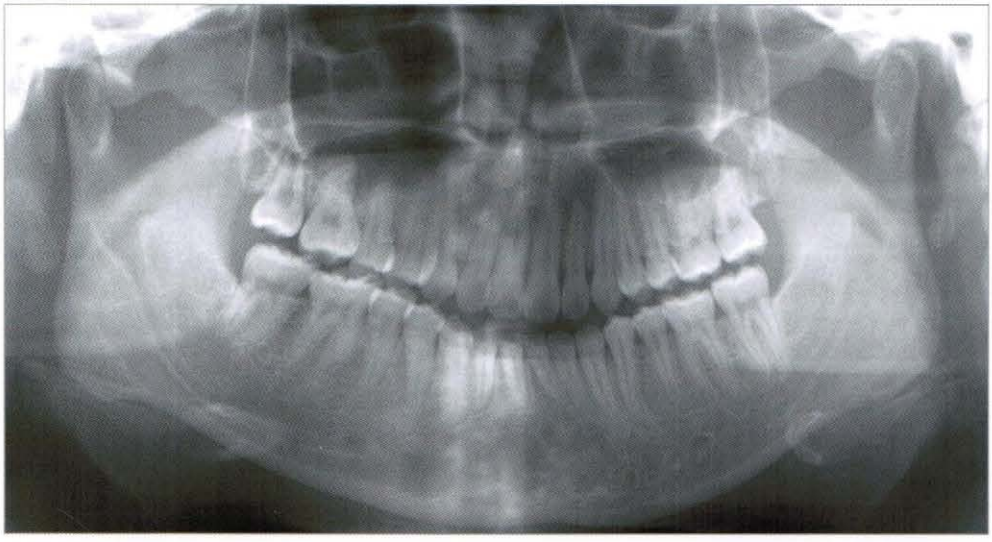


Figure 7-3-22. Panoramic radiograph at debonding (2007. 3.22)
There is no root resorption.

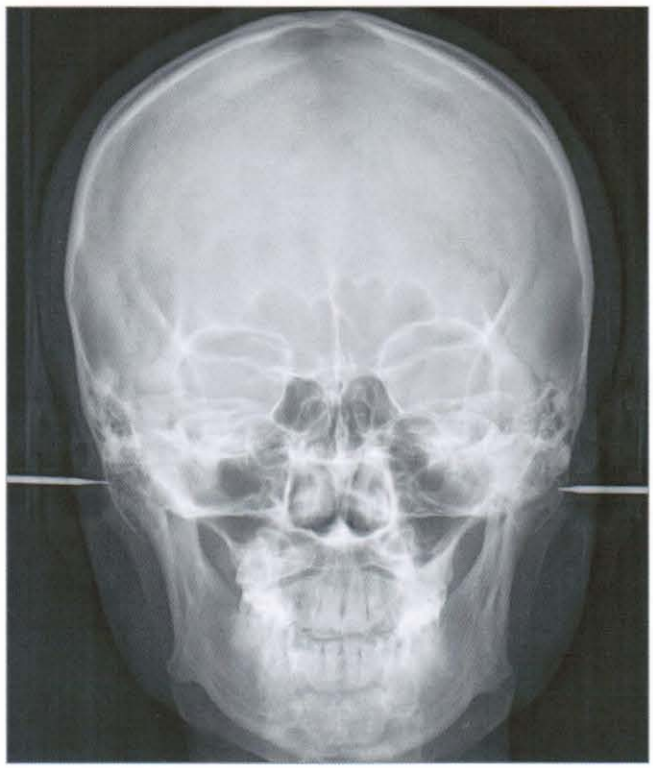


Figure 7-3-23. Post-treatment postero-anterior radiograph (2007. 3.22)
The facial asymmetry present before treatment can still be seen.

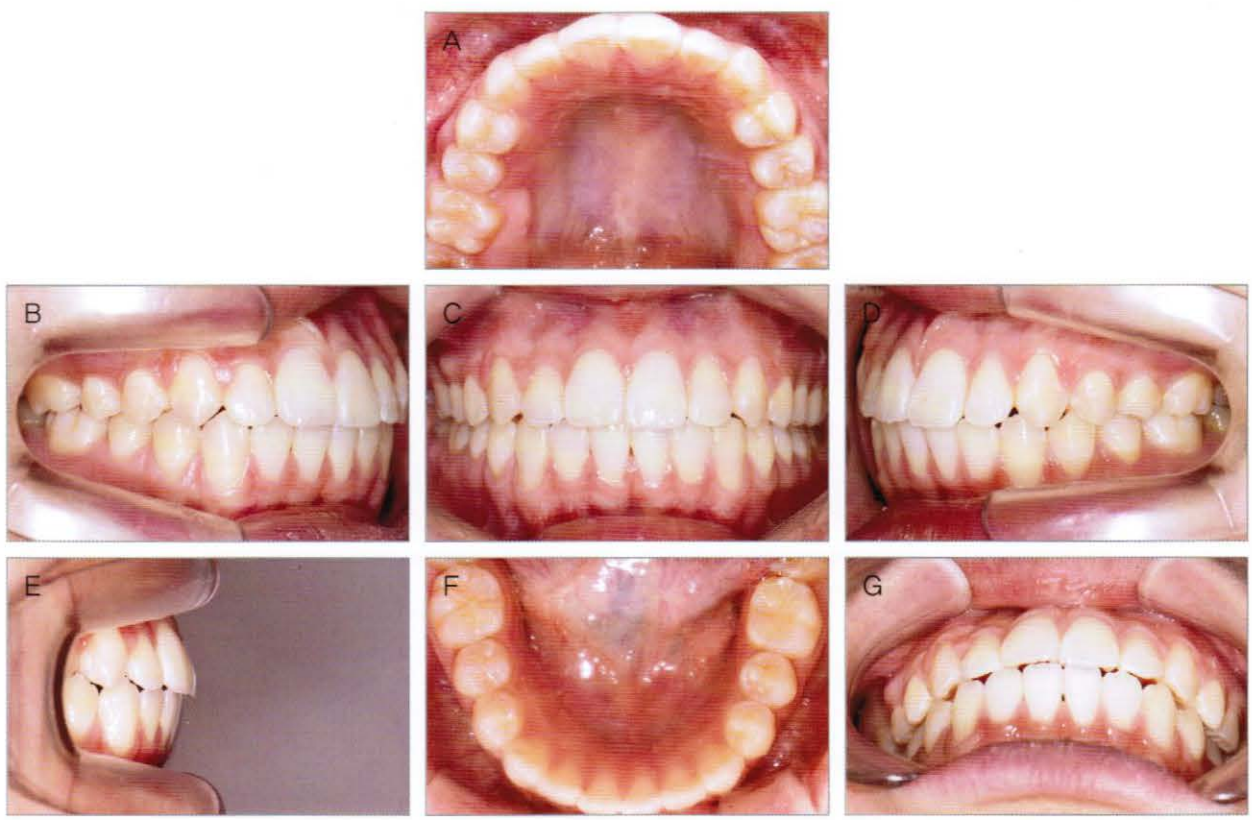


Figure 7-3-24. Intraoral photograph at 1 year retention (2008. 3.21)
Better interdigitation has been achieved.

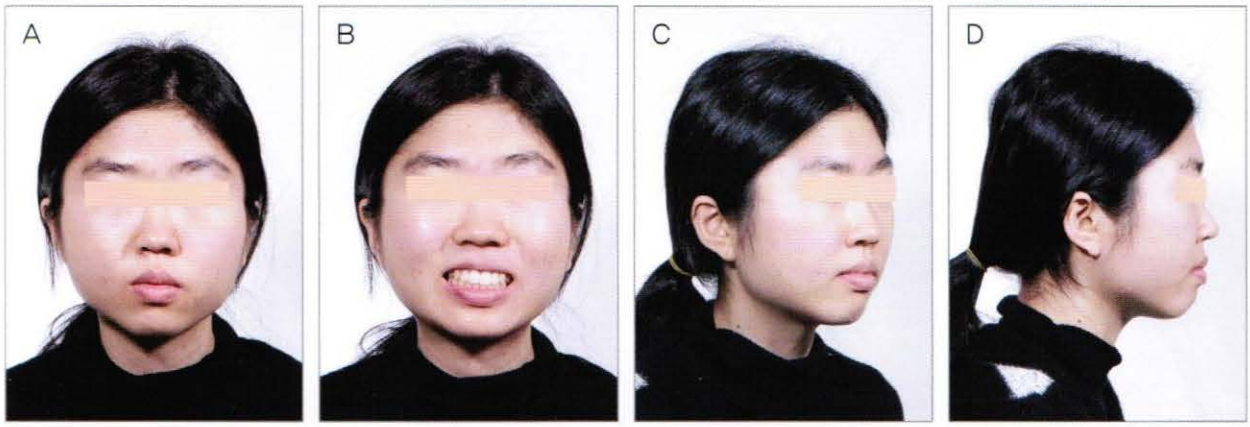


Figure 7-3-25. Facial photograph at 1 year retention (2008. 3.21)

Figure 7-3-26. Cephalometric radiograph at 1 year retention (2008. 3.21)

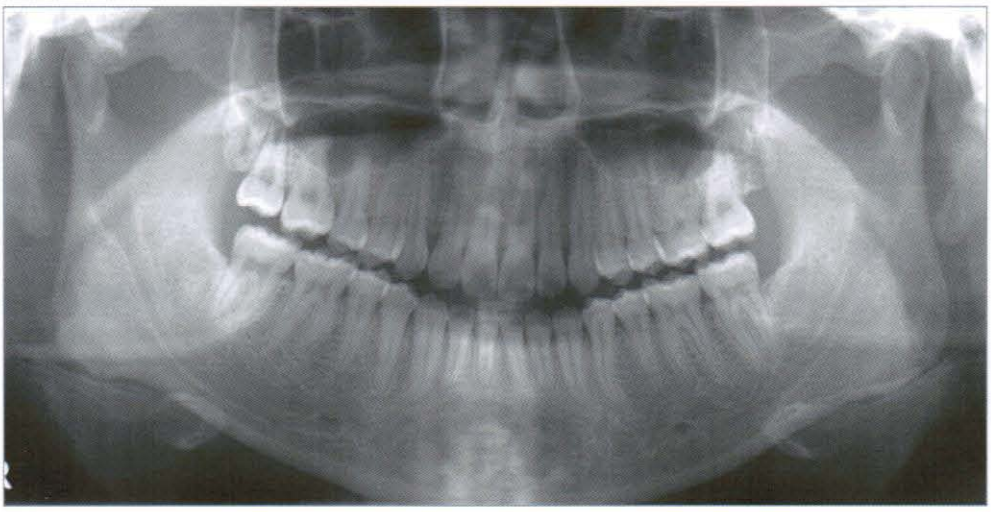


Figure 7-3-27. Panoramic radiograph at 1 year retention (2008. 3.21)

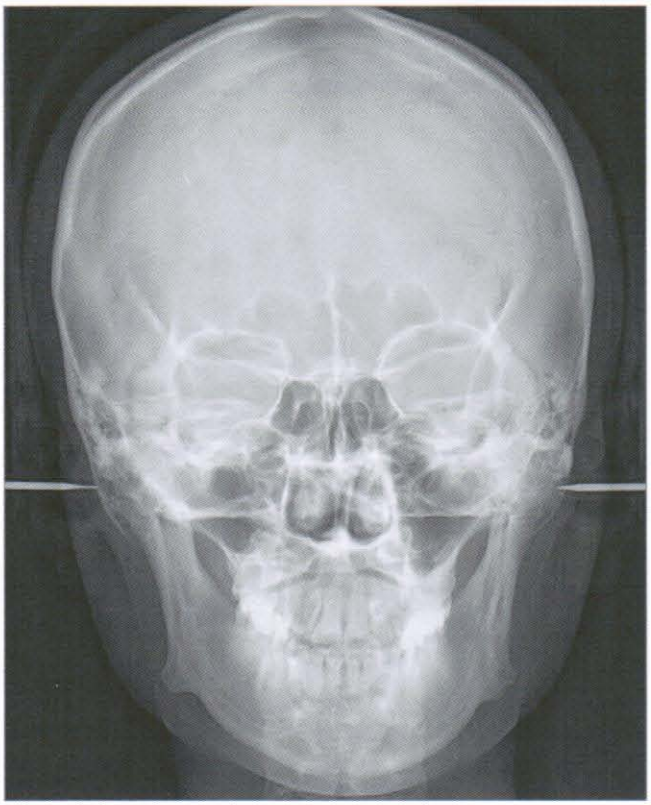


Figure 7-3-28. Postero-anterior radiograph at 1 year retention (2008. 3.21)

■ Case 13 (Figure 7-4-1 to 18)

- Age : 37 years 8 months
- Sex : male
- Chief complaint : Referred from Department of Prosthodontics for the restoration of #36, 45 & 46
- Special features : #15, 36, 45, 46 missing, with severe Class II open bite and crowding.

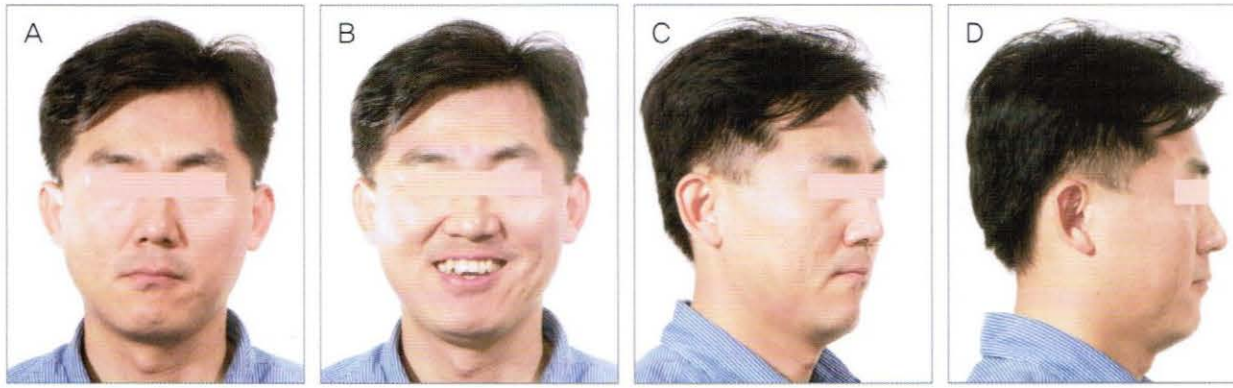


Figure 7-4-1. Pre-treatment facial photograph of Case 13 (2006. 9.4)
The patient's chief complaint was the missing of many teeth.
A. Upper incisor protrusion and large overjet with open bite means that the lips must be pursed to close the mouth.
B. Upper midline is deviated to the right.
C, D. The upper lip is protruded, but the patient has forced the lips together for the photograph.

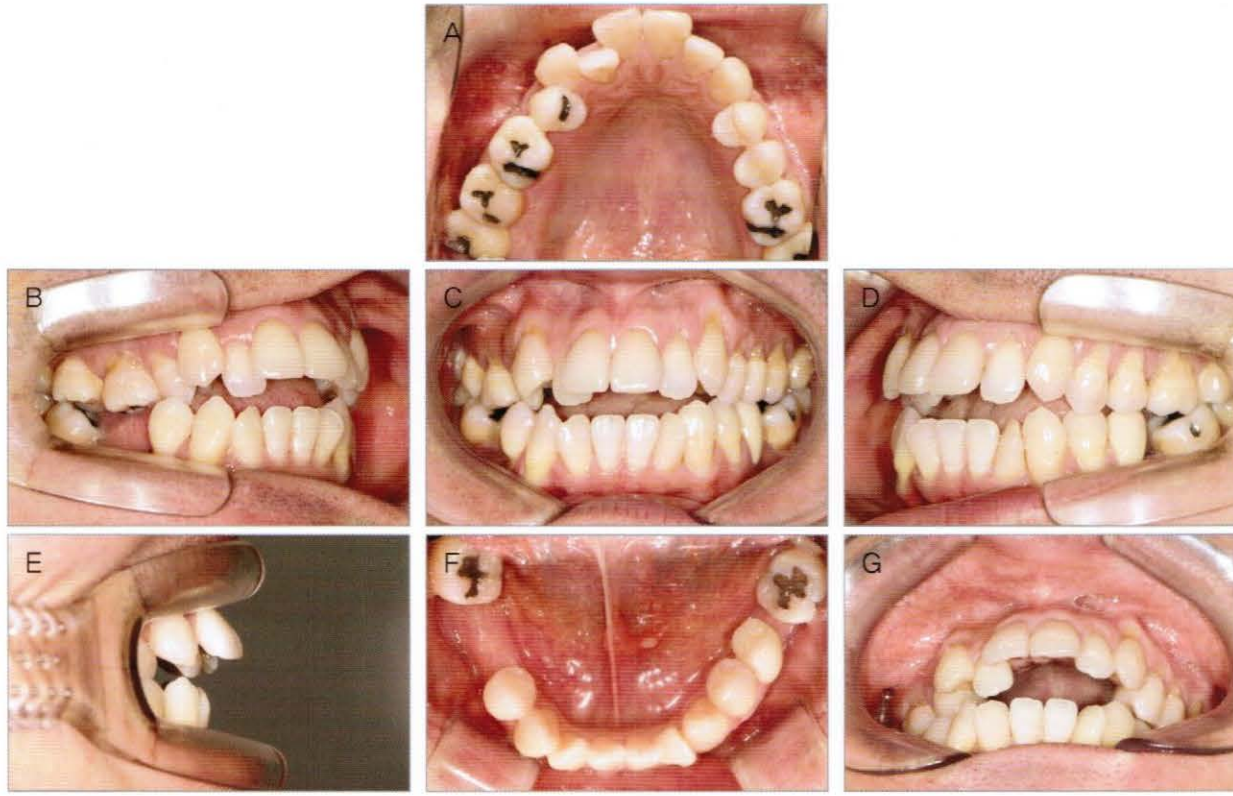
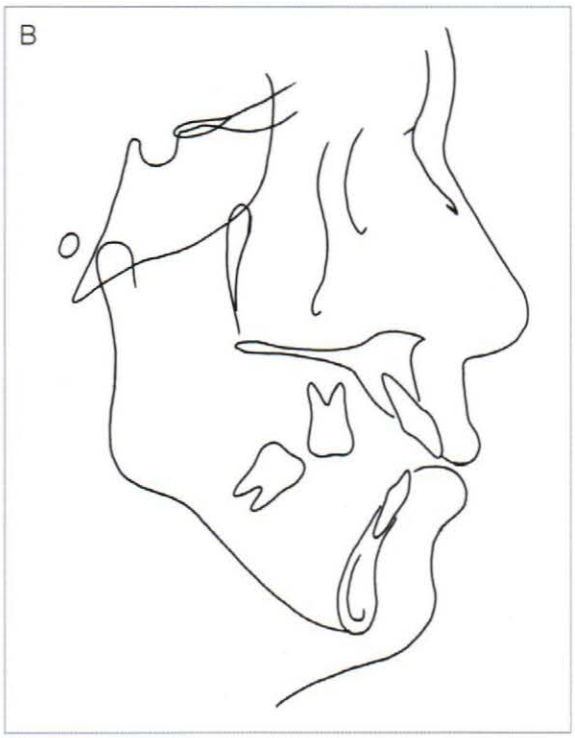


Figure 7-4-2. Pre-treatment intraoral photograph of Case 13 (2006. 9.4)
#15, 36, 45, 46 are missing (A, B), with severe Class II open bite and crowding. The left canine and first molar relationship is Class II (D). Upper midline is deviated to the right (C, G), and shows a large overjet (E, G). The upper right first molar is in crossbite (B).



C

	Norm	SD	T1
SNA	82.5	3.2	85.3
SNB	80.4	3.1	80.6
ANB	2.1	1.7	4.7
FMA	22.7	5.3	34.0
ODI	73.3	5.9	64.5
U1 to FH	116.3	5.6	124.9
IMPA	96.6	6.6	80.8
IIA	124.4	8.0	120.4
Esth-U	-0.7	2.2	-1.7
Esth-L	0.5	2.3	-2.0

Figure 7-4-3. Pre-treatment cephalometric radiograph (A), tracing (B) and measurement (C) (2006. 9.4)
A. He shows characteristics of Class II open bite.
B, C. The antero-posterior skeletal pattern can be said to be Class II. Upper and lower central incisors show labioversion.

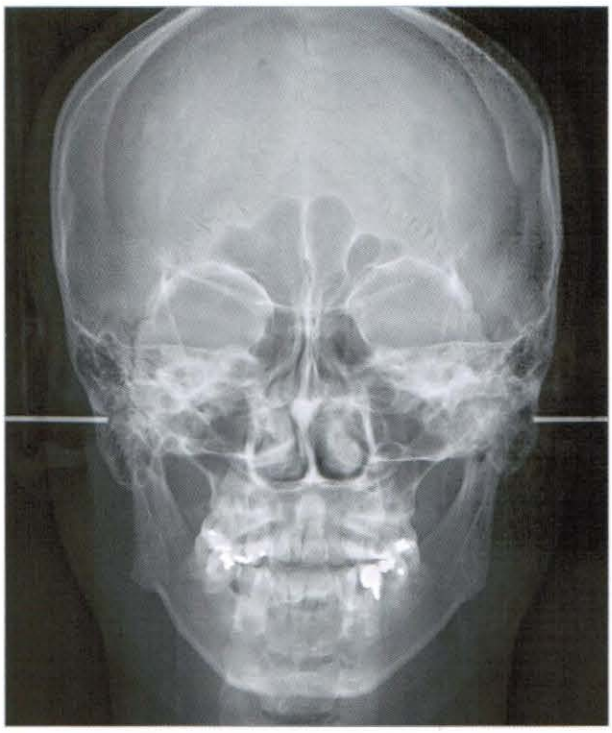


Figure 7-4-4. Pre-treatment postero-anterior radiograph (2006. 9.4)
Slight skeletal asymmetry is evident. The mandible is deviated to the right. Upper incisor midline shows severe deviation to the right.

Figure 7-4-5. Pre-treatment panoramic radiograph (2006. 9.4)
Lower right second and third molars show severe mesial tilting. Left second and third molars are also tilted mesially. Generally the level of alveolar bone is low.

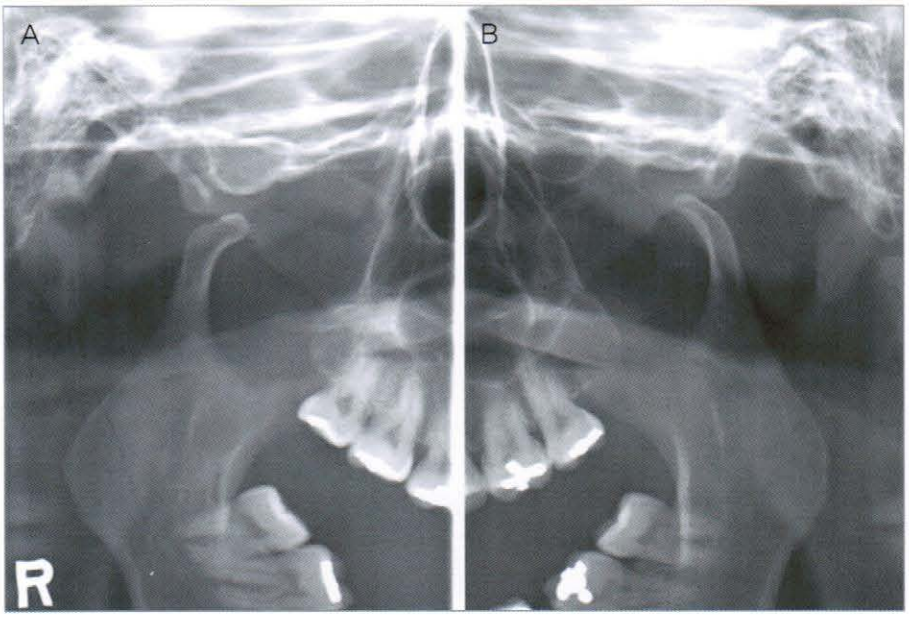


Figure 7-4-6. Pre-treatment TMJ panoramic radiograph (2006. 9.4)
Both TMJ show clicking, and the left side sometimes shows locking. The left condyle is long and thin.

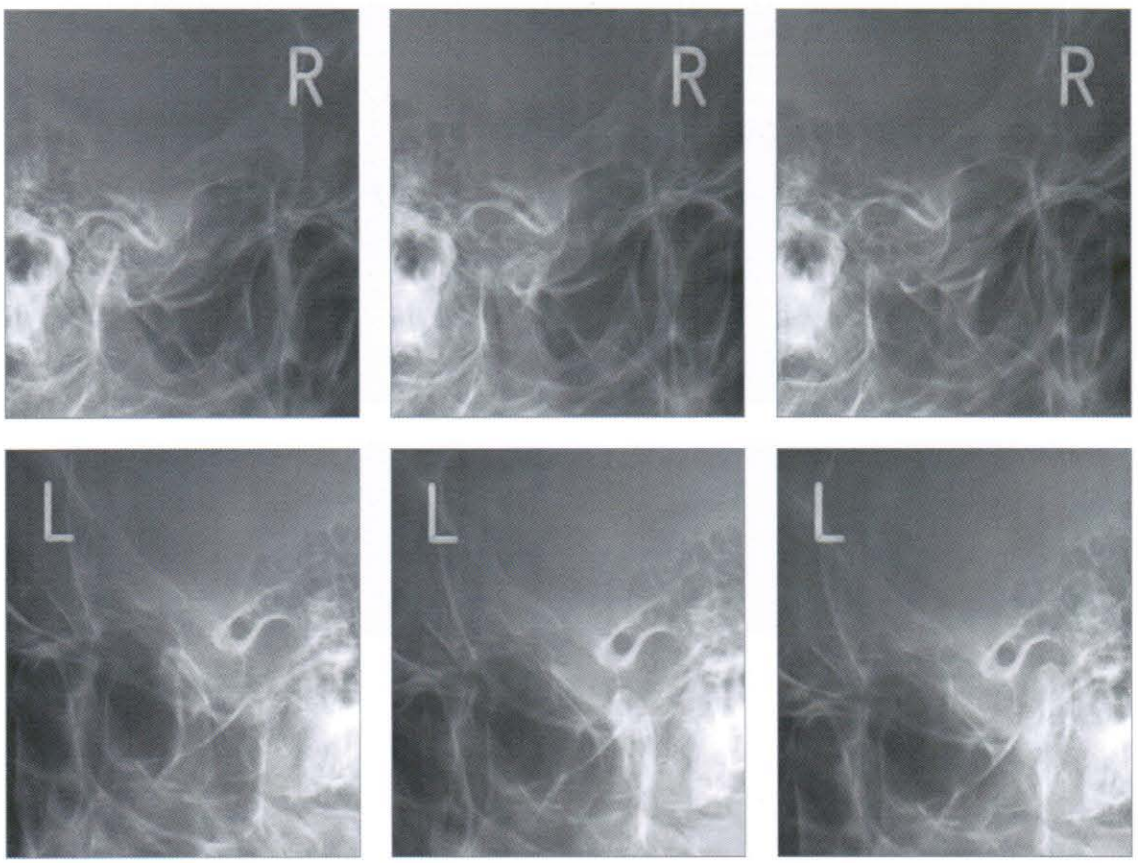


Figure 7-4-7. Pre-treatment transcranial radiograph (2006. 9.4)
Left closed state (lower right image) shows a fairly wide joint space. There were no problems with movement.

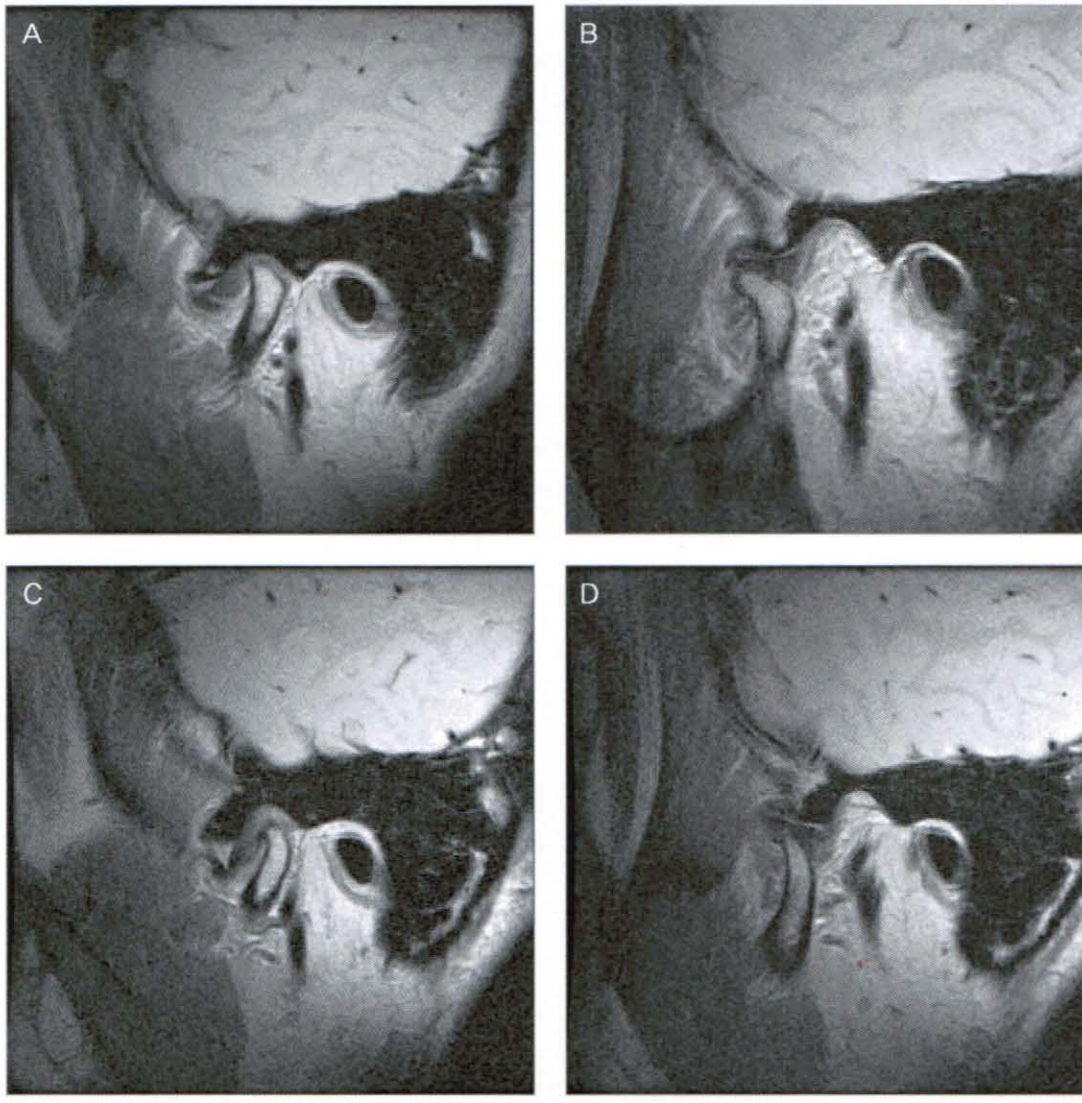


Figure 7-4-8. Pre-treatment TMJ MRI (2006. 11.13)
On MRI, both joints showed ADD with reduction. This may the reason for clicking and locking.
A. Right closed state. B. Right maximal open state. C. Left closed state. D. Left maximal open state.

Treatment Progress

▪ Leveling & distal driving

- 2006. 12.15 — 014″ NiTi except for #32 & 42
- 2007. 1.12 — 016″ NiTi except for #32 & 42
- 2007. 2.7 — U : 018″ss + open coils between 16, 13 & 11
  L : 018″ NiTi except for #32 & 42
- 2007. 3.7 — L : 018″ss + open coils between 31 & 33
  + open coils between 41 & 43
- 2007. 4.10 — Implantation 1.6×6.0 1EA ⌊6↓4⌋
- 2007. 4.17 — Buccal SPA for distal driving of #16 & 17
- 2007. 5.25 — U : 016″ NiTi
- 2007. 6.22 — U : 018″ NiTi
- 2007. 7.25 — U : 016×022″ NiTi
  L : 014″ NiTi + Temple spring for regaining space for #32
- 2007. 9.18 — U : 018×022″ ss with shoe hooks
  L : 016″ NiTi
- 2007. 10.26 — L : 018″ NiTi
- 2007. 11.23 — L : 016×022″ NiTi

▪ Traction and uprighting of #37

- 2007. 12.7 — Implantation 1.6×6.0 1EA ⌈4↑5⌉
- 2007. 12.12 — Bonding 0.7mm wire segment between #35 and the head of the mini-implant
  L : 018×022″ ss with a T-loop for mesial traction and uprighting of #37
- 2008. 4.15 — Open coil activation between #44 and 47

▪ Detailing

Under detailing of the occlusion at present.

This case shows a skeletal Class II relationship with open bite. As discussed in the earlier open bite case, 70% of Class II open bite shows disk displacement. On MRI exam, ADD with reduction was confirmed (Figure 7-4-8). Also partial bending of the disk can be thought to be the cause of locking. On transcranial radiograph, the left joint space was large (Figure 7-4-7). This may be the cause of CO-CR discrepancy.

There were no special symptoms prior to orthodontic treatment. After explaining to the patient, treatment was commenced.

The prosthodontic department referred the patient for only uprighting of #36, 45, and 46, but after discussion with the patient, comprehensive orthodontic treatment was planned. Even with the upper right premolar missing, there was severe crowding (Figure 7-4-2A). Because the upper incisors are protruded with labioversion, retraction is required. But any more extraction is difficult because a premolar is already missing.

On the upper right side, Buccal SPA will be used for distalization of first and second molars for space provision, and further space will be made by correcting the deviated upper central incisor midline. On the left side of the maxilla, the first premolar will be extracted, and the space closed through incisor retraction and molar loss forward. After uprighting of the lower right second molar, implants are to be placed in the lower right second premolar and first molar spaces. The left first molar space will be closed through molas loss forward. For reinforcement of the lower left anterior region, a mini-implant will be inserted between the first and second premolars, with fixation of the first premolar to the mini-implant head (Figure 7-4-14C, 7-4-17) for uprighting and mesial movement of the lower left second molar.

Figure 7-4-9. Mini-implant insertion between the upper right first premolar and first molar
A. After leveling to 018″ stainless steel wire, a periapical radiograph was taken to investigate the interradicular space for mini-implant insertion. The radiograph is well taken with no overlapping of the first premolar and first molar contact point.
B. Kim's stent was used to decide on the position of the mini-implant. The second hook from the right is chosen (2007. 4.11)
C. The mini-implant has been implanted precisely between the roots. 1.6×6.0mm mini-implant was inserted buccally (2007. 4.11)

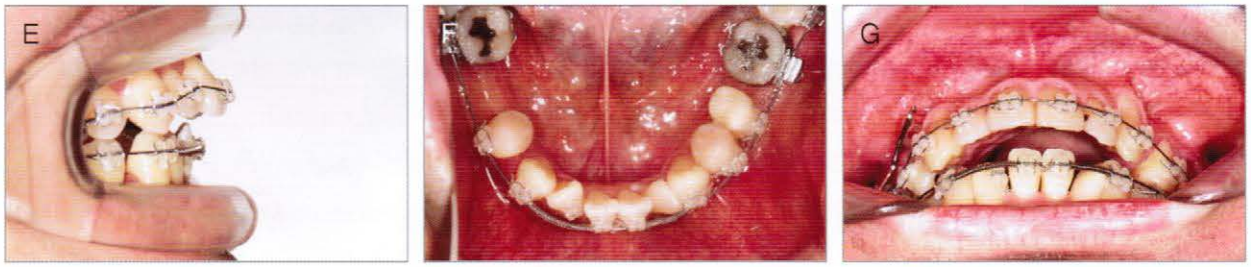


Figure 7-4-10. Distalization of upper right first molar (2007. 5.25)
Buccal SPA is inserted. 016" NiTi upper archwire, and 018" ss archwire is ligated. Lower open coil spring is being used in the lower arch to regain space for the lateral incisor.

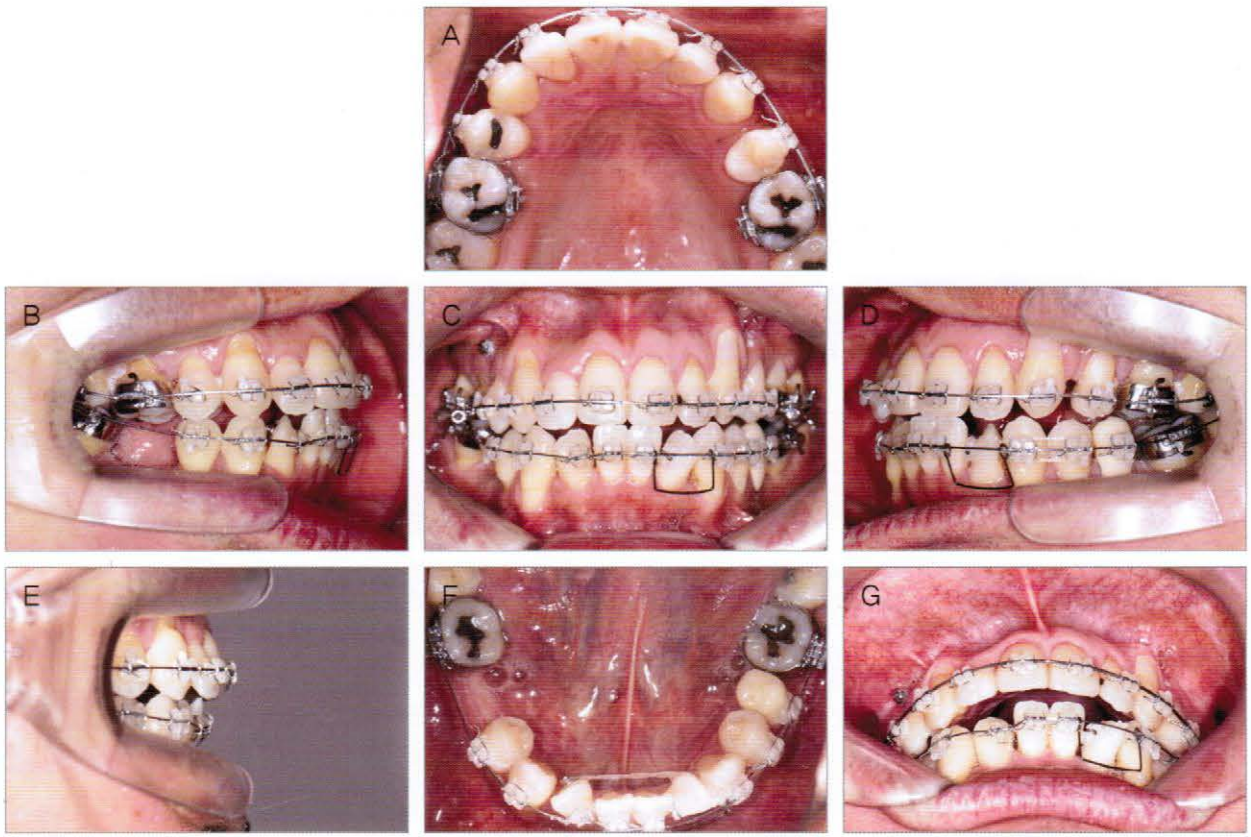


Figure 7-4-11. Intraoral photograph after 4 months of SPA use (2007. 7.28)
Upper right first molar has been distalized and rotated (A). Upper left first molar space has also closed half way (B). Distalization of upper right first molar and mesial movement of left molars has allowed the position of the left first molar to become symmetrical compared to pre-treatment. Temple spring is being used to regain space for the lower lateral incisor (C). Power chain has been placed between a lingual button on the lower right lateral incisor and the bracket of the left lateral incisor for rotation (F). The large overjet has decreased (G).

Figure 7-4-12. Mini-implant insertion for uprighting and protraction of lower second molar (2007. 12.7)
A, B. Two periapical radiographs are taken to check the interradicular distances.
C. 1.6×6.0mm mini-implant has been inserted between the lower first and second premolars.

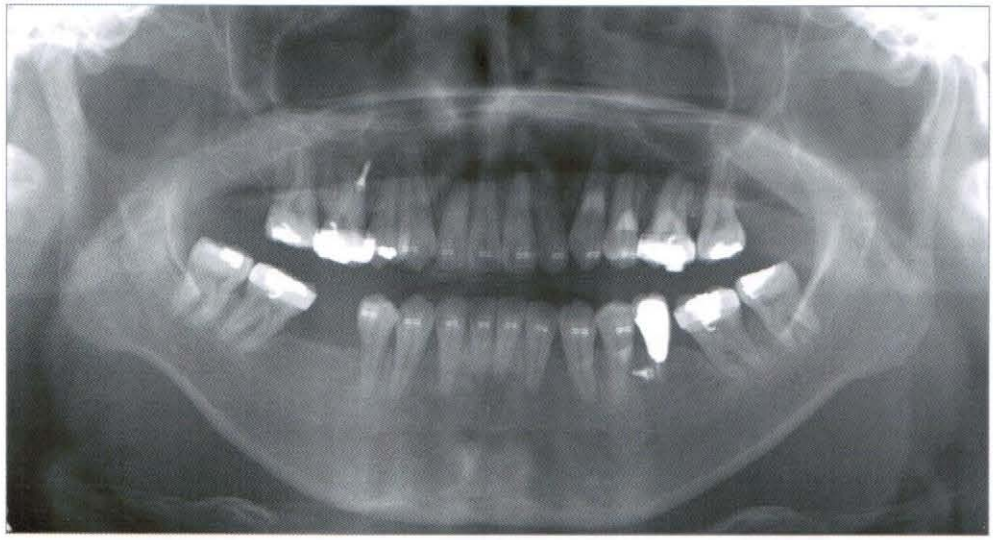


Figure 7-4-13. Examination of lower second molar axis, alveolar bone height, and root resorption (2007. 12.7)
Regular panoramic radiographs were taken because the roots are short and alveolar bone level low. Both lower second molars need to be uprighted further.

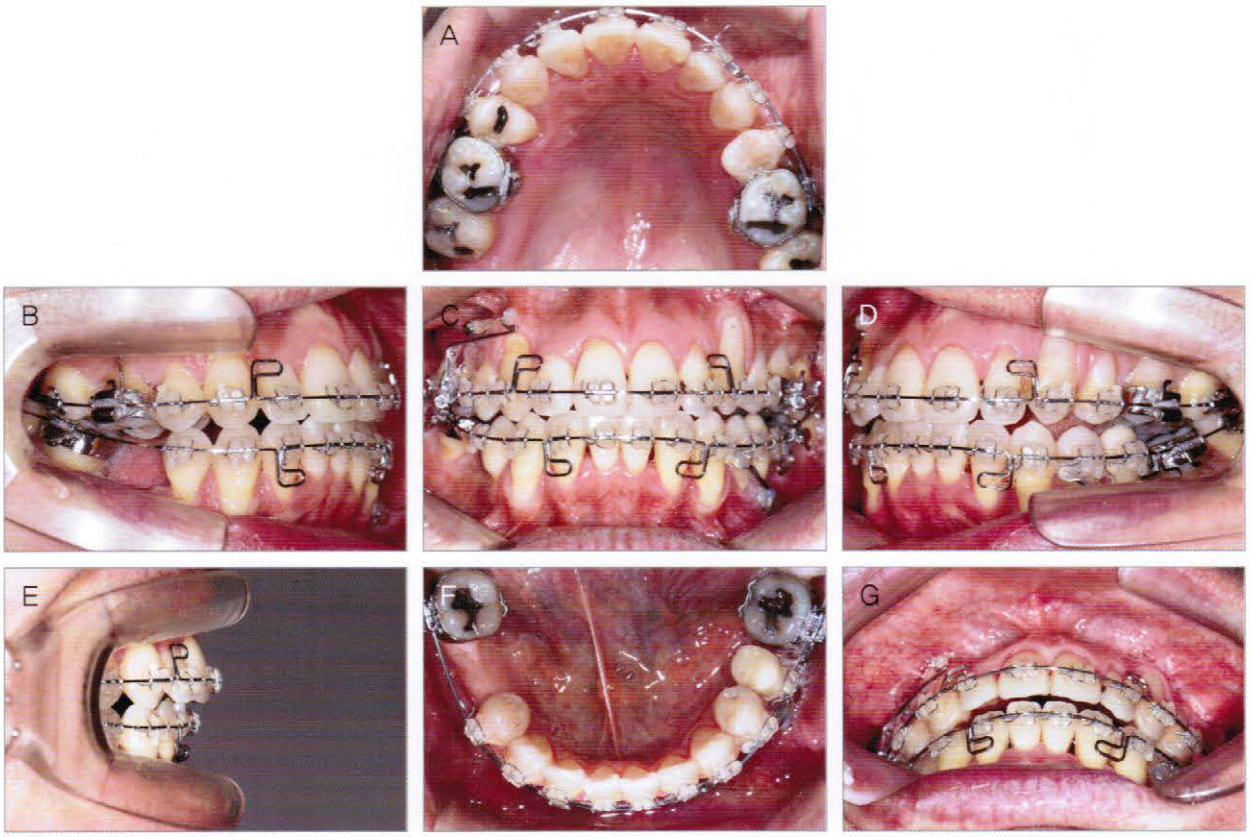


Figure 7-4-14. Recent intraoral photograph (2007. 12.12)
The first premolar extraction space is nearly closed (A). Right canine relationship is still Class II (B). This is because the ratio of mandibular teeth is larger. Stripping was carried out on the lower incisors on two occasions as the mesio-distal width was large and black triangles were present. Upper and lower midlines are coincident (C). 0.7mm ss wire was bonded between the lower fist premolar and mini-implant head (C). Left canine relationship has been corrected to Class I (D). The lower left first molar space is nearly closed (F). Overjet is reduced (G).

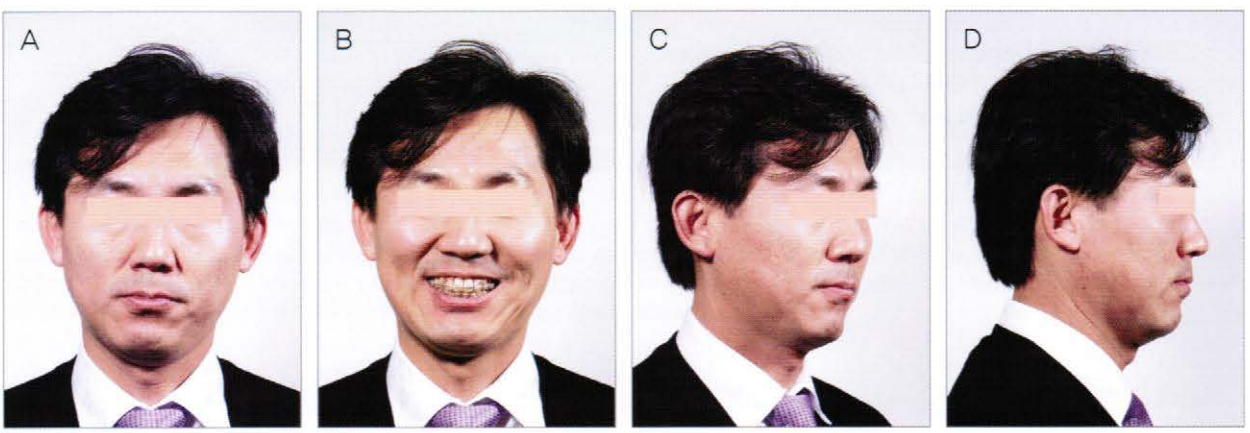
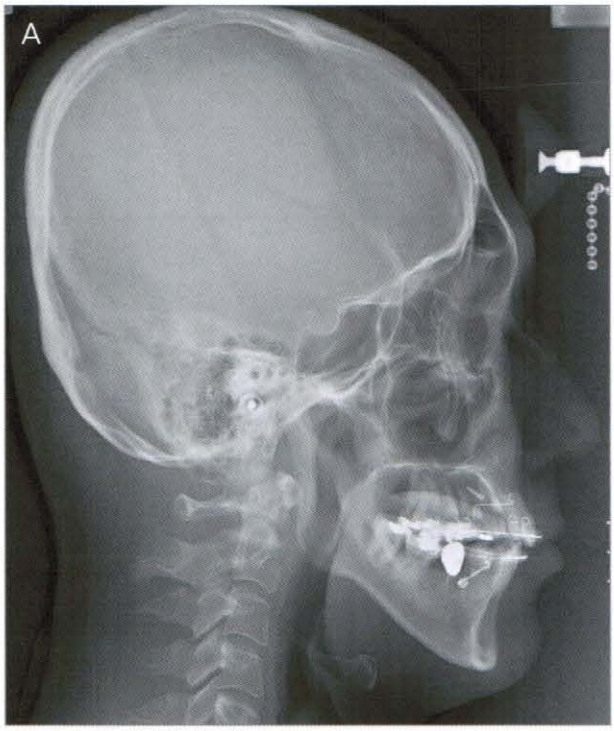
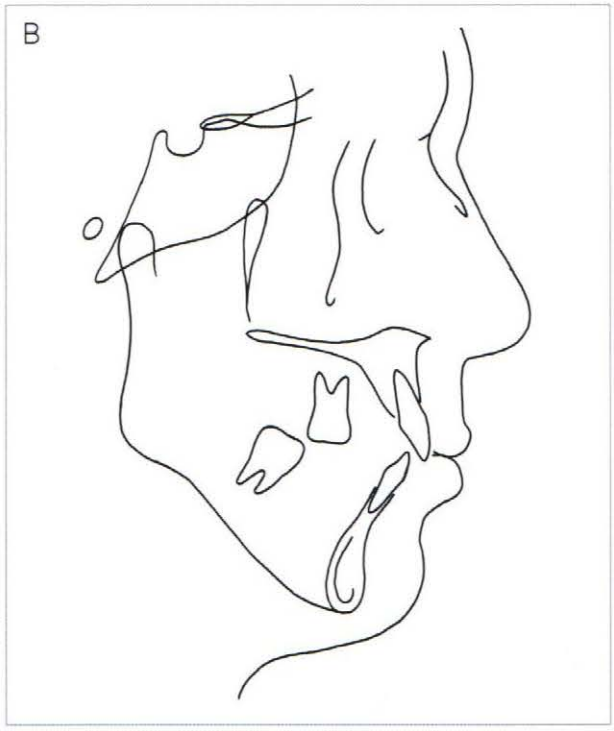
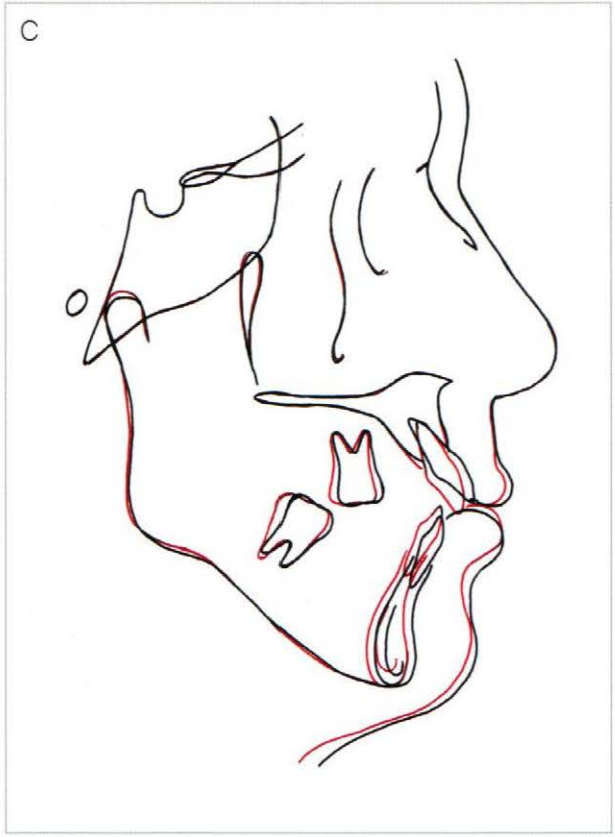
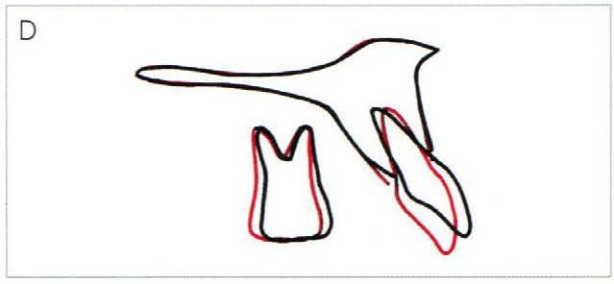


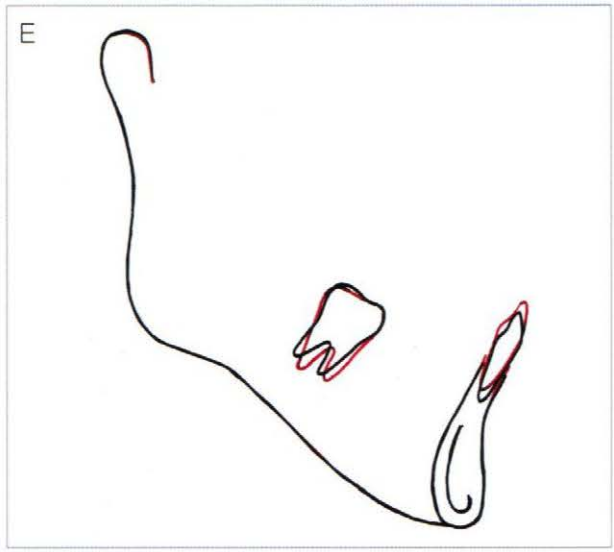
Figure 7-4-15. Recent facial photograph (2007. 12.12)
Mouth closure has become much easier.


A


B


C


D


E

F

	Norm	SD	T1	T2
SNA	82.5	3.2	85.3	83.6
SNB	80.4	3.1	80.6	78.8
ANB	2.1	1.7	4.7	4.9
FMA	22.7	5.3	34.0	37.1
ODI	73.3	5.9	64.5	63.6
U1 to FH	116.3	5.6	124.9	109.9
IMPA	96.6	6.6	80.8	84.1
IIA	124.4	8.0	120.4	129.0
Esth-U	-0.7	2.2	-1.7	-2.4
Esth-L	0.5	2.3	-2.0	-0.7

Figure 7-4-16. Recent cephalometric radiograph and measurement (2007. 12.12)
A. Recent cephalometric radiograph
B. Tracing of cephalometric radiograph
C. Superimposition of pre-treatment and recent cephalometric radiograph. Upper incisors have been retracted. The mandible has moved back slightly. CO-CR discrepancy is thought to be the cause.
D. Superimposition of maxilla. Upper right first molar has been traced. The tooth has been tilted distally around 2mm from Buccal SPA use.
E. Superimposition of mandible. Left first molar has been traced. Slight uprighting has occurred.
F. T1 is pre-treatment, T2 is from the recent radiograph.

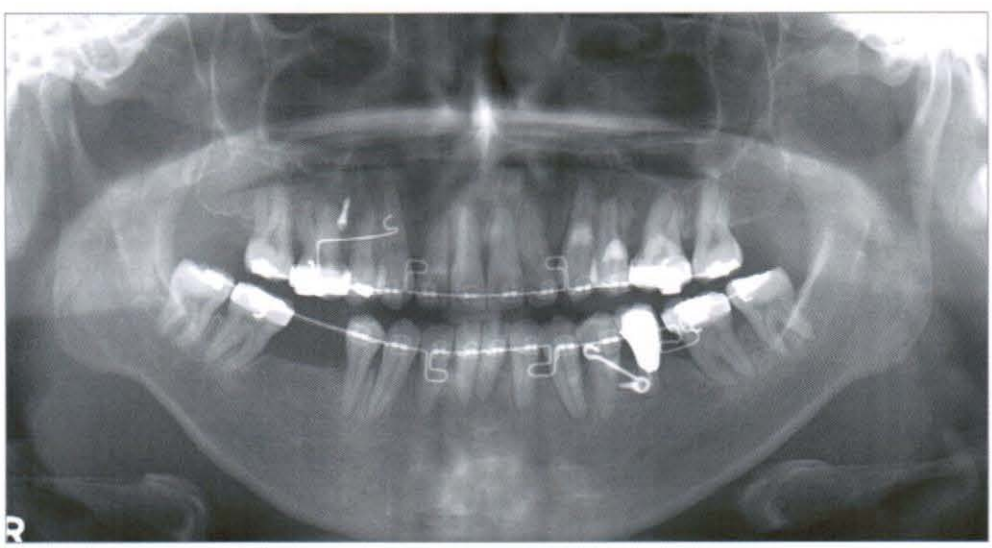


Figure 7-4-17. Recent panoramic radiograph (2008. 2.12)
Lower first premolar and mini-implant have been fixed together with wire. T-loop can be seen distally.

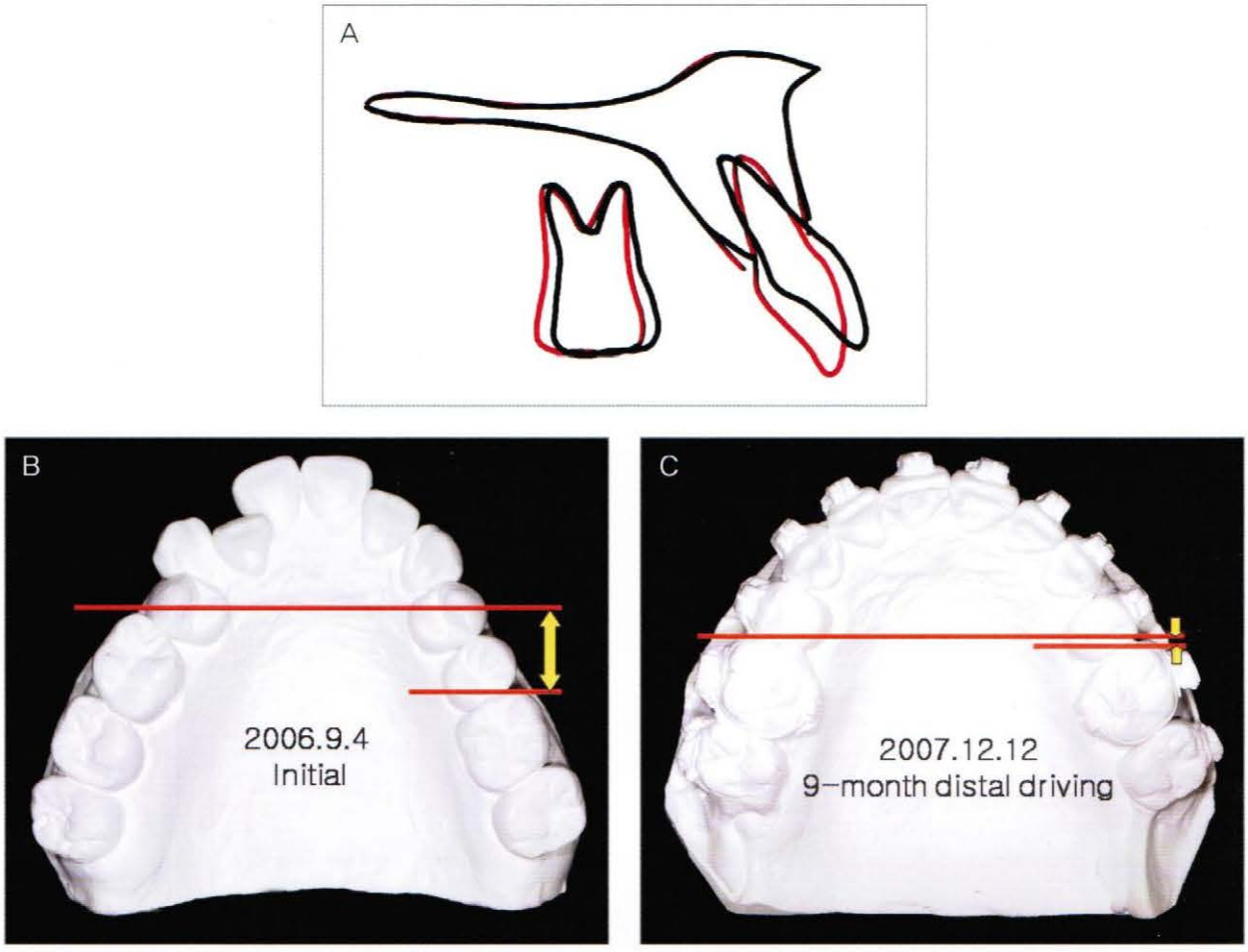


Figure 7-4-18. Comparison of pre-treatment and recent (2007. 12.12) study model
A. Superimposition of the upper right first molar shows that it has tipped distally.
B. Pre-treatment upper study model. There is a large difference in the antero-posterior level of the right and left first molars.
C. Recent upper study model. Upper right molar distalization through Buccal SPA and left first premolar extraction treatment has improved the symmetry of the first molar levels.

Clinical tip ››››

Treatment of rotated or mesially tipped upper first molar

Early loss of the second premolar or primary second molar will cause mesial tipping of the upper first molar with rotation of the mesio-buccal cusp palatally (Note the right first molar in Figure 7-4-18B). This is because the tooth rotates around the thick palatal cusp.

Buccal SPA provides distal force from the buccal side, which causes distal tipping and rotation of the mesio-buccal cusp bucally. This provides effective treatment mechanics (Note the right first molar in Figure 7-4-18C).

Chapter 8

Various applications of mini-implant

Chapter 8 Various applications of mini-implant

This chapter will look at examples of various clinical cases using mini-implants.

I . Forced eruption

Fractured root can be extruded for prosthodontic treatment.

■ Case 14 (Figure 8-1-1 to 15)

- Age : 18 years 4 months
- Sex : male
- Chief complaint : Fracture of upper left central incisor. Referred for root extrusion from the Restorative department, as the lingual subgingival fracture prevents formation of a good crown margin.

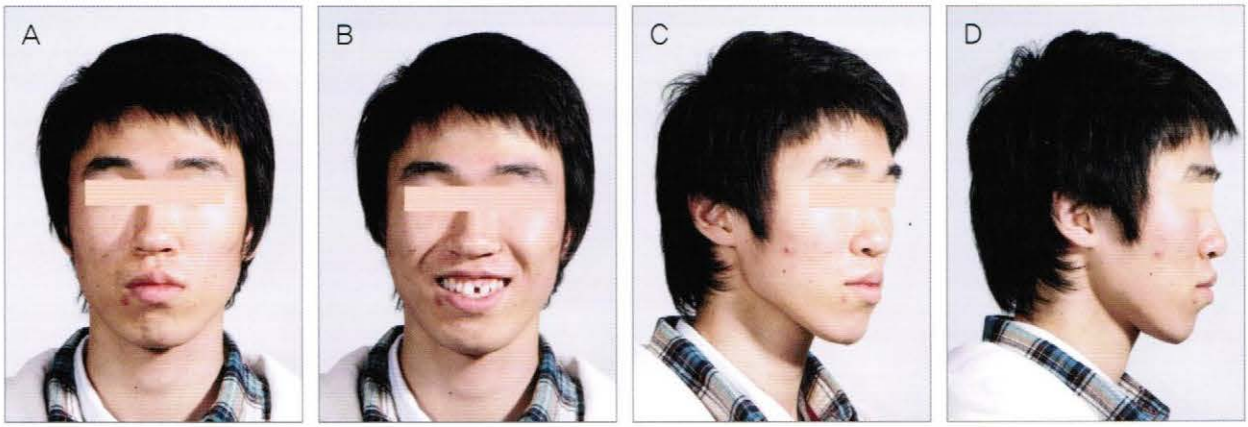


Figure 8-1-1. Pre-treatment facial photograph of Case 14
Fracture of the upper left central incisor can be seen. Mouth is slightly protruded, but the patient did not want full orthodontic treatment.

Figure 8-1-2. Pre-treatment intraoral photograph of Case 14 (2006. 12.27)
There is crowding in both arches. The patient only wanted extrusion of the upper left central incisor for prosthodontic treatment, and refused full orthodontic treatment. The deep fracture line on the lingual side of the upper left central incisor has been covered by gingival tissue (H, arrow).

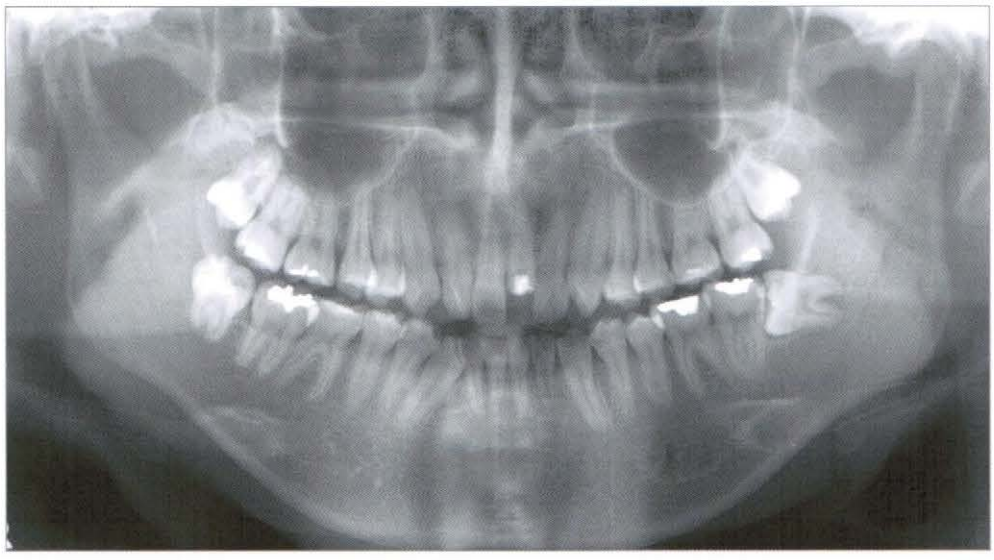


Figure 8-1-3. Pre-treatment panoramic radiograph

Figure 8-1-4. Pre-treatment periapical radiographs
The panoramic and periapical radiographs were examined, and decided to insert mini-implants between the fairly wide interradicular spaces between the upper central incisors and lateral incisors on both sides.

Treatment Progress

- **Implantation**
  - 2007. 4.10 — Labial 1.6×6.0 2EA 2↓1|1↓2
    Fixed retainer on 321|23
- **Forced eruption** — 4 months
  - 2007. 4.13 — Bonding brackets (022) on 3 1|1 3
    + 019×025″ ss + 014″ NiTi overlay
  - 2007. 5.29 — 018″ NiTi + grinding of incisal edge of |1
  - 2007. 7.18 — 018″ ss
  - 2007. 8.6 — Removal of fixed retainer
- **Debonding**
  - 2007. 8.14 — Removal of brackets and wire + Preparation of |1
- **Follow-up check**
  - 2007. 11.28
  - 2007. 1.14

After taking panoramic and periapical radiographs, 1.6x6.0mm mini-implants were inserted between the upper central and lateral incisors on both sides (Figure 8-1-5).

Mechanics (Figure 8-1-6)

The fractured upper left central incisor was fitted with a temporary crown at the Restorative department. The upper right canine, right central incisor and left lateral incisor were bonded with brackets passively (refer to Clinical tip) and inserted with 019x025″ ss to prevent force being placed on the anchor teeth. On the upper left central incisor, the bracket was bonded around 3.5mm towards the gingiva considering the amount of intrusion required (Figure 8-1-6H).

0.7mm ss wire segments were used to bond the upper right central incisor and left lateral incisor to the mini-implant heads (Figure 8-1-6H).

To make the anchor teeth more rigid, a fixed retainer was bonded from canine to canine with the exception of the upper left central incisor (Figure 8-1-6I). A 1mm space was given between the upper left central incisor and fixed retainer so that the retainer will not prevent tooth extrusion if the lingual part of the tooth contacts the retainer with continued extrusion (Figure 8-1-6I, arrow).

019x025″ ss wire was ligated in the upper right canine, right central incisor and left canine brackets making sure that it was passive. 014″ NiTi wire was overlayed over the left central incisor. 019x025″ ss and 014″ NiTi is ligated together over the right canine, right central incisor and left canine (Figure 8-1-6H). With continued extrusion of the upper left central incisor, the incisal edge of the temporary crown is ground down. Around 3~4mm of extrusion was achieved after 4 months of forced eruption. A new temporary crown was made after debonding and retainer was not used.

Clinical tip ››››

What is passive bonding?

After bracket bonding, the wire is ligated without putting force on the teeth, even when heavy wire is used. The existing tooth alignment is to be maintained. Note that the brackets are not placed in the normal positions.

1) One method, especially when only a few teeth need to be bonded such as Case 14, is to check the slots with the naked eye and bond directly. This is appropriate for experienced clinicians.
2) The other method is to bond brackets onto the study model and transfer indirectly to the mouth. Bond brackets onto the study model with 019x025″ ss wire ligated. Take a putty impression, and transfer to the patient's mouth. Another method is to bond brackets on the study model by checking at each step whether the 019x025″ ss wire sits passive in the bracket slots. Transfer to the mouth using silicone putty, bond the brackets and ligate the archwire after minor adjustments in the mouth.

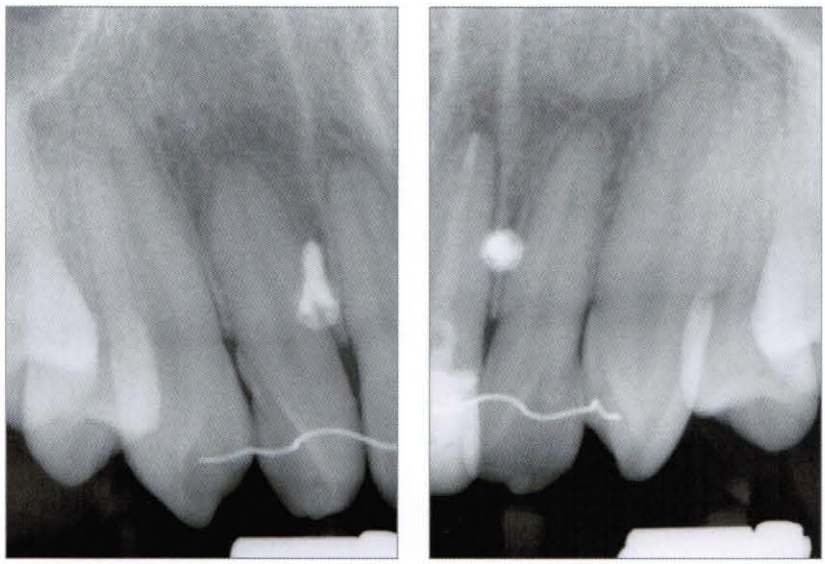


Figure 8-1-5. Periapical radiographs taken after inserting 1.6×6.0mm mini-implants between the upper central and lateral incisors on both sides (2007. 4.10)

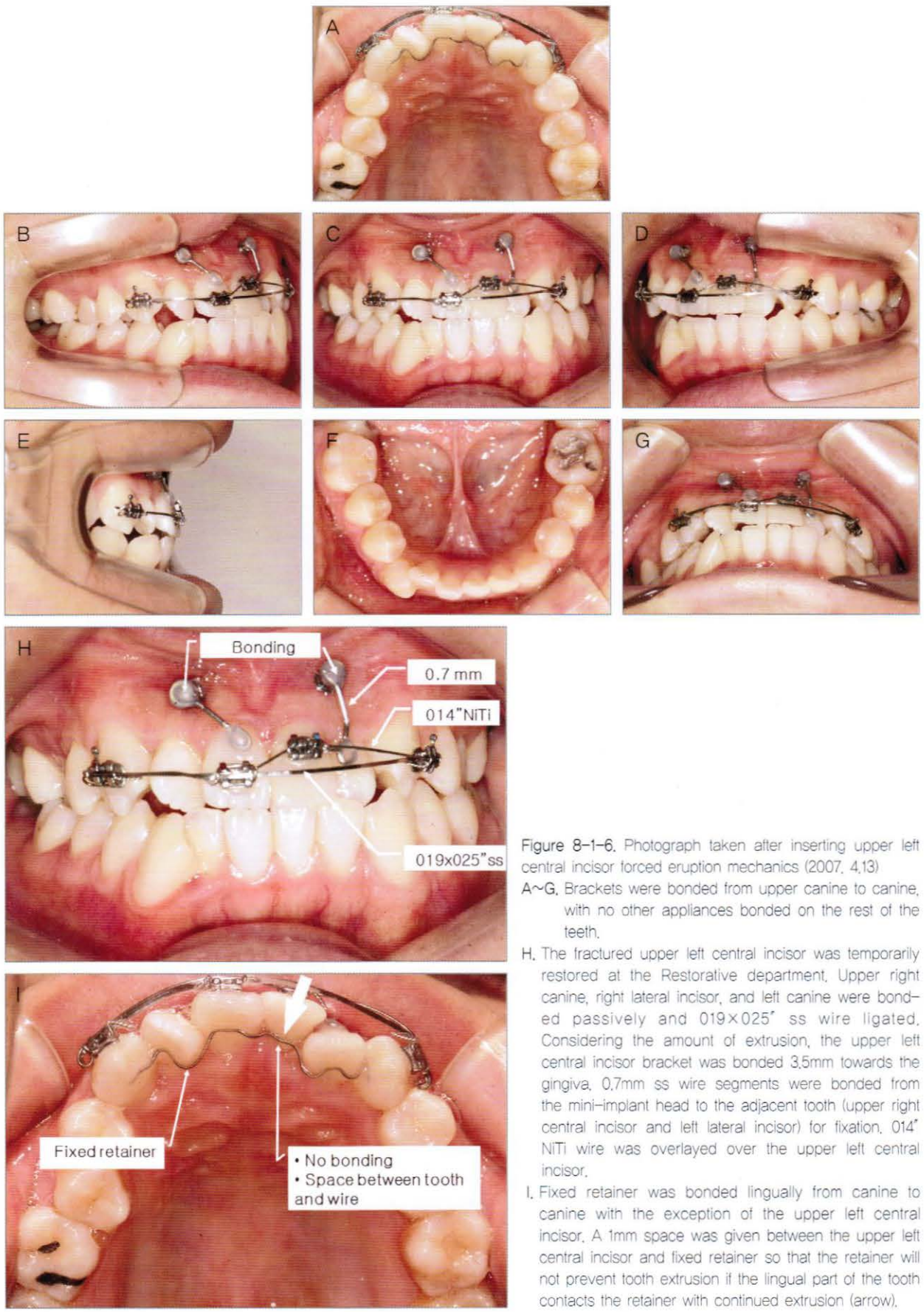


Figure 8-1-6. Photograph taken after inserting upper left central incisor forced eruption mechanics (2007. 4.13)

A~G. Brackets were bonded from upper canine to canine, with no other appliances bonded on the rest of the teeth.

H. The fractured upper left central incisor was temporarily restored at the Restorative department. Upper right canine, right lateral incisor, and left canine were bonded passively and 019×025" ss wire ligated. Considering the amount of extrusion, the upper left central incisor bracket was bonded 3.5mm towards the gingiva. 0.7mm ss wire segments were bonded from the mini-implant head to the adjacent tooth (upper right central incisor and left lateral incisor) for fixation. 014" NiTi wire was overlayed over the upper left central incisor.

I. Fixed retainer was bonded lingually from canine to canine with the exception of the upper left central incisor. A 1mm space was given between the upper left central incisor and fixed retainer so that the retainer will not prevent tooth extrusion if the lingual part of the tooth contacts the retainer with continued extrusion (arrow).

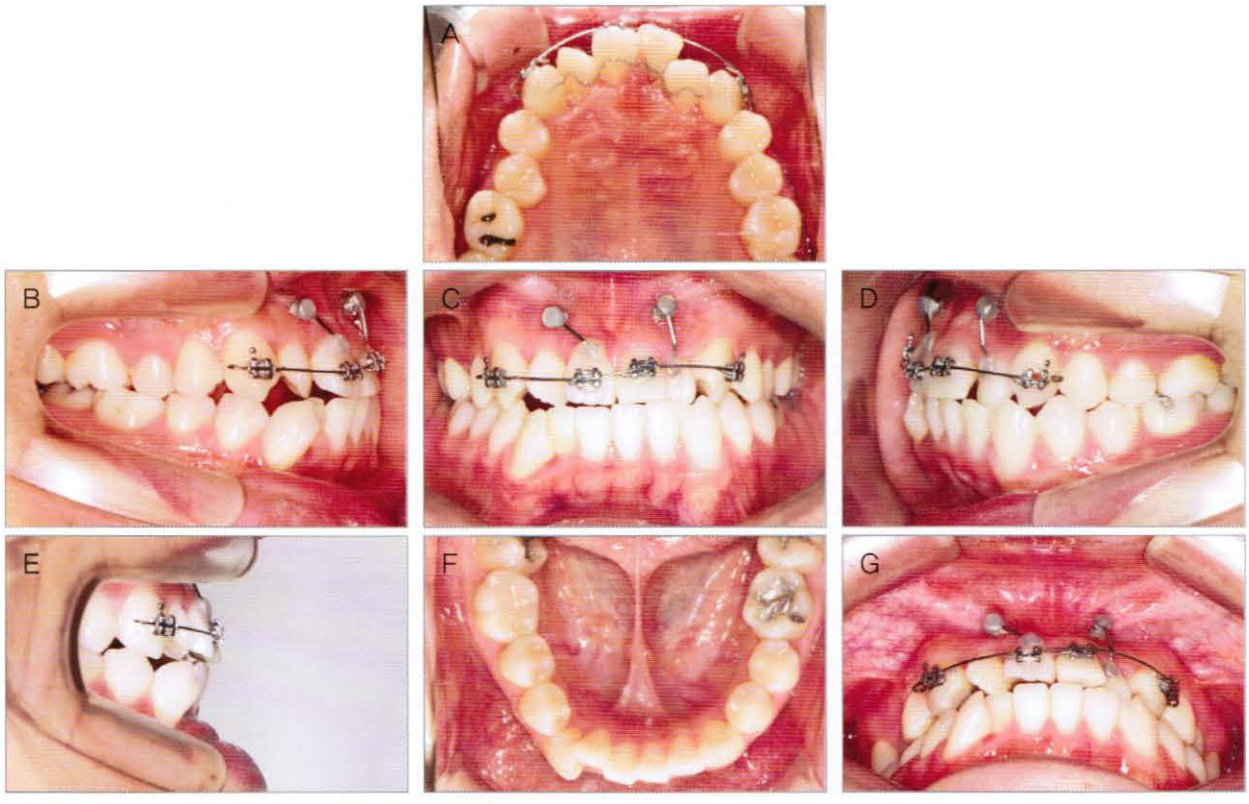


Figure 8-1-7. Intraoral photograph after 2 months of forced eruption (2007. 6.15)
Upper left central incisor has been extruded. 019×025″ ss and 014″ NiTi wire has been replaced with 018″ NiTi. The incisal edge of the left central incisor was ground regularly so that it does not contact the lower incisors.

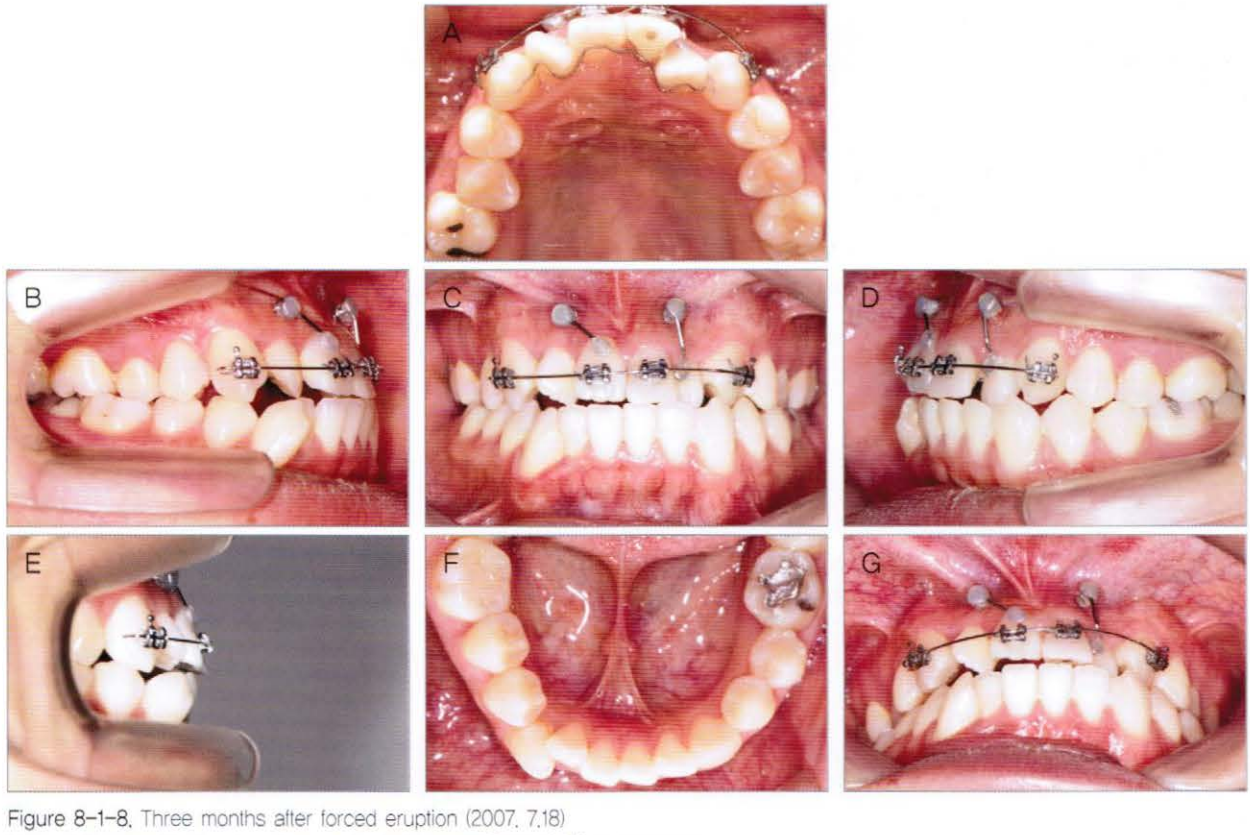


Figure 8-1-8. Three months after forced eruption (2007. 7.18)
Upper left central incisor has been extruded around 3mm. 018″ ss is ligated.

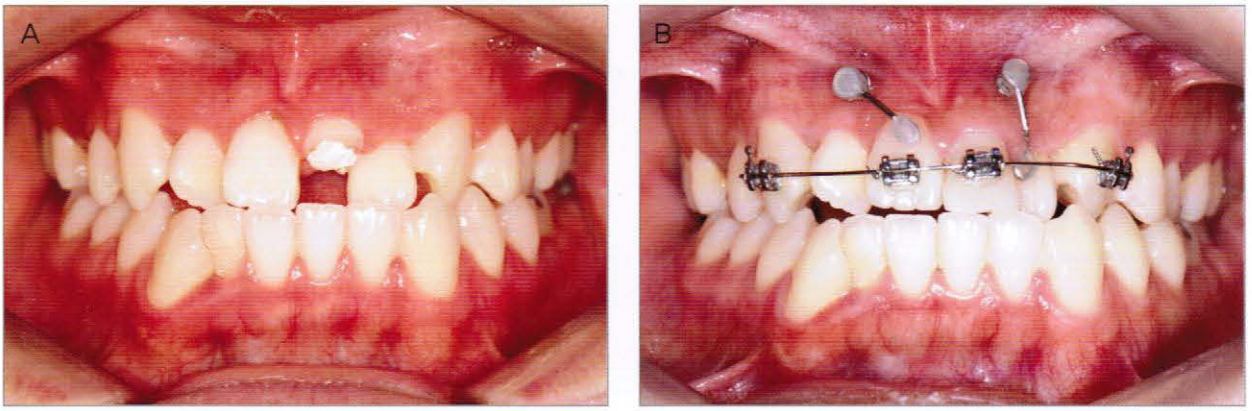


Figure 8-1-9. Change after 3 months of forced eruption
With extrusion of the left central incisor, the right central incisor has been intruded slightly (B). The bite between the upper right central incisor and lower right central incisor is open around 0.5mm. Around 3.5mm of extrusion has occurred, with the gingival line also being pulled down towards the incisal edge.

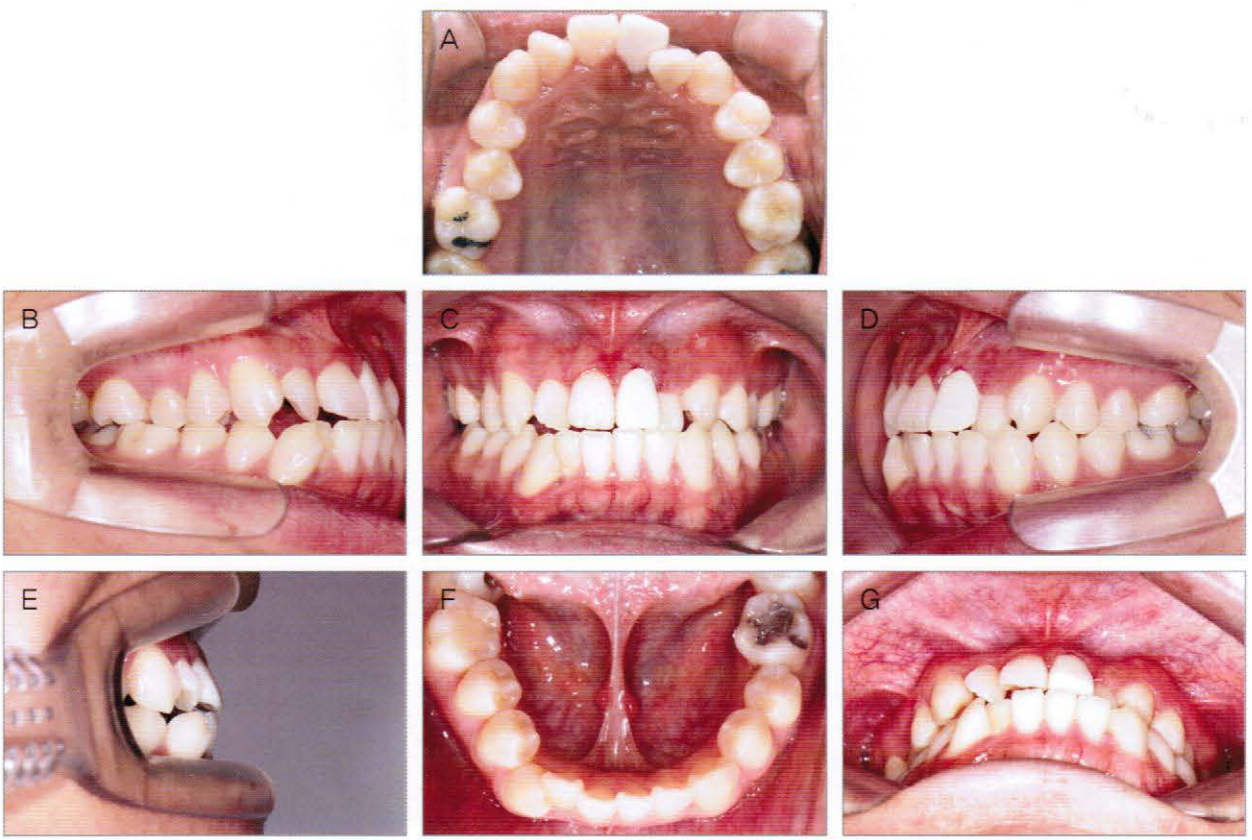


Figure 8-1-10. Intraoral photograph at debonding, after 4 months of forced eruption (2007. 8.14)
After gingivectomy, the temporary crown has been re-made.

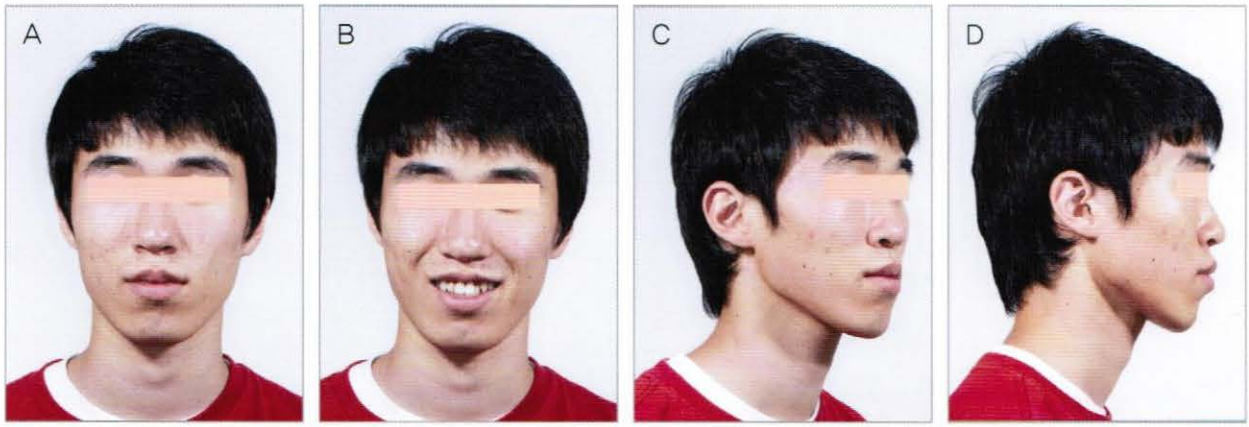


Figure 8-1-11. Facial photograph at debonding, after 4 months of forced eruption (2007. 8.14)

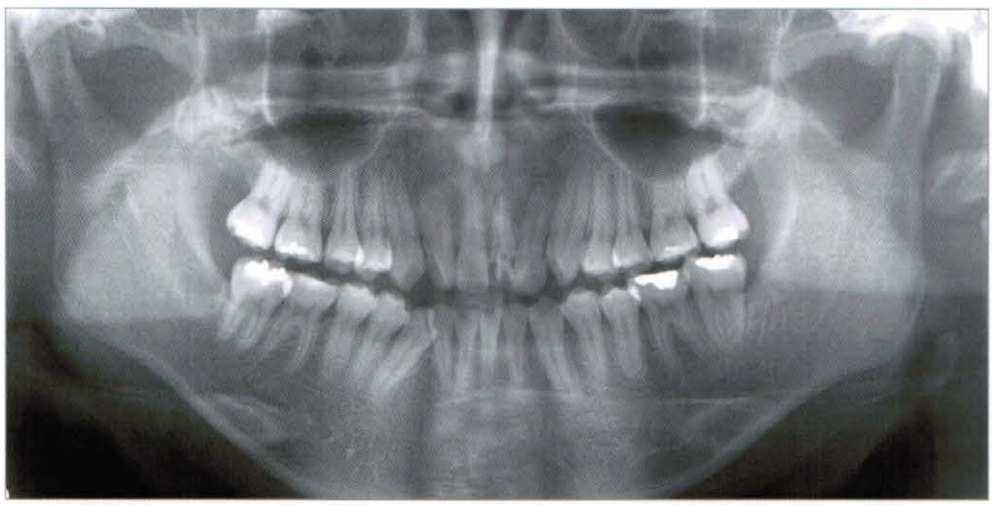
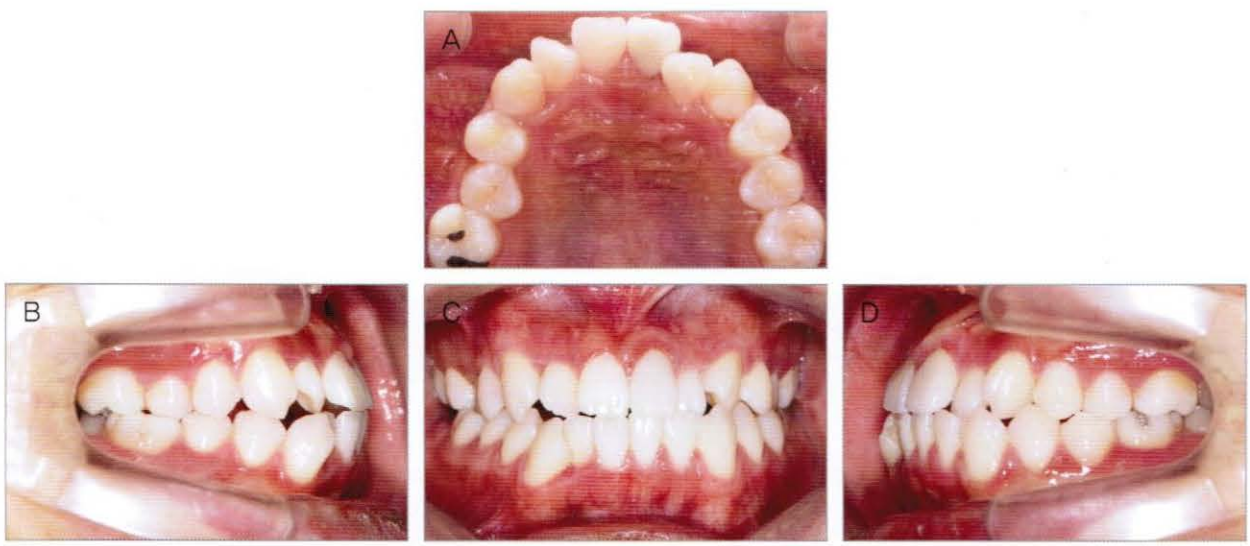


Figure 8-1-12. Panoramic radiograph at debonding, after 4 months of forced eruption (2007. 8.14)
Comparing the level of the upper central incisor root tip, the eruption amount can be estimated.



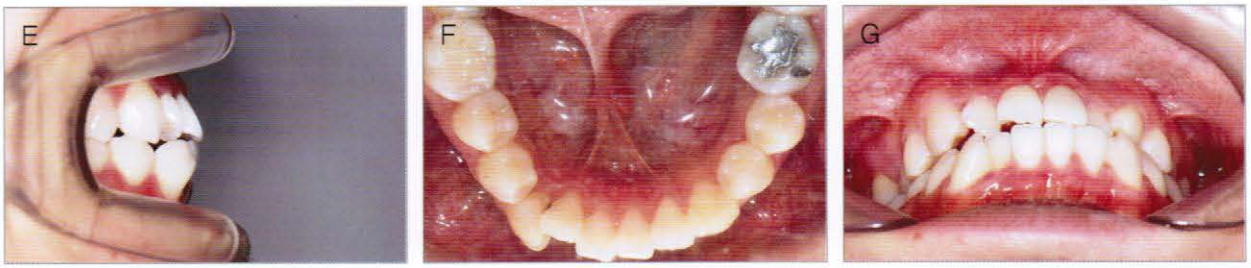


Figure 8-1-13. Intraoral photograph after permanent crown (2007. 11.29)
Prosthodontic work was finished 3 months after debonding.
The slightly intruded upper right central incisor (Figure 8-1-9B) has relapsed to its original position.

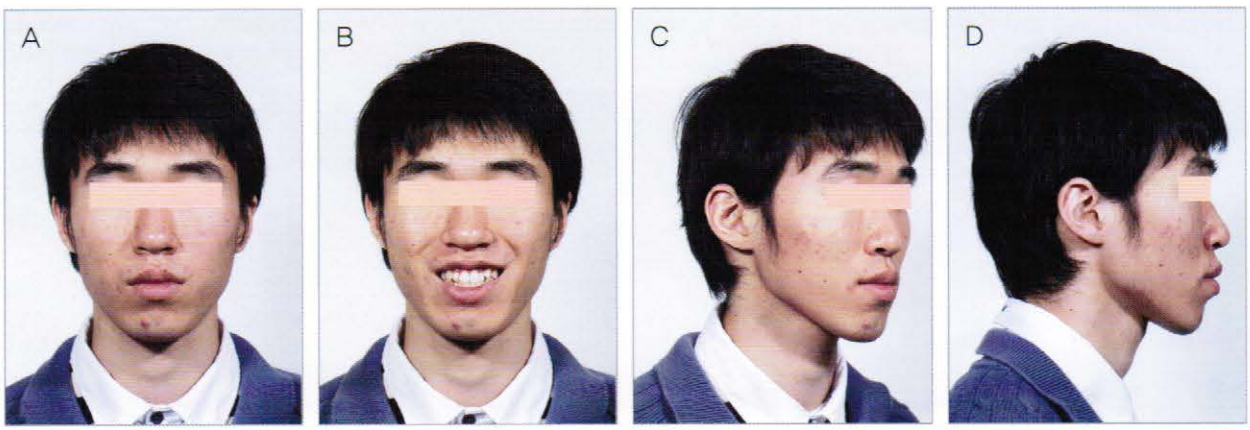


Figure 8-1-14. Facial photograph after permanent crown (2007. 11.29)

Figure 8-1-15. Periapical radiograph after permanent crown (2007. 11.29)
The root of the upper left central incisor is short due to forced eruption.

Ⅱ. Molar uprighting

Effective uprighting of tilted molars will be useful for prosthodontic treatment planning. Case 15 shows the effective uprighting of a mesially tilted lower second molar using a mini-implant.

■ Case 15 (Figure 8-2-1 to 10)

- Age : 26 years 7 months
- Sex : female
- Chief complaint : She wanted the uprighting of both lower second molars to be able to receive prosthodontic work. Referred from the Prosthodontic department. The left side is severely tilted, whereas the right side shows only slight tilting.

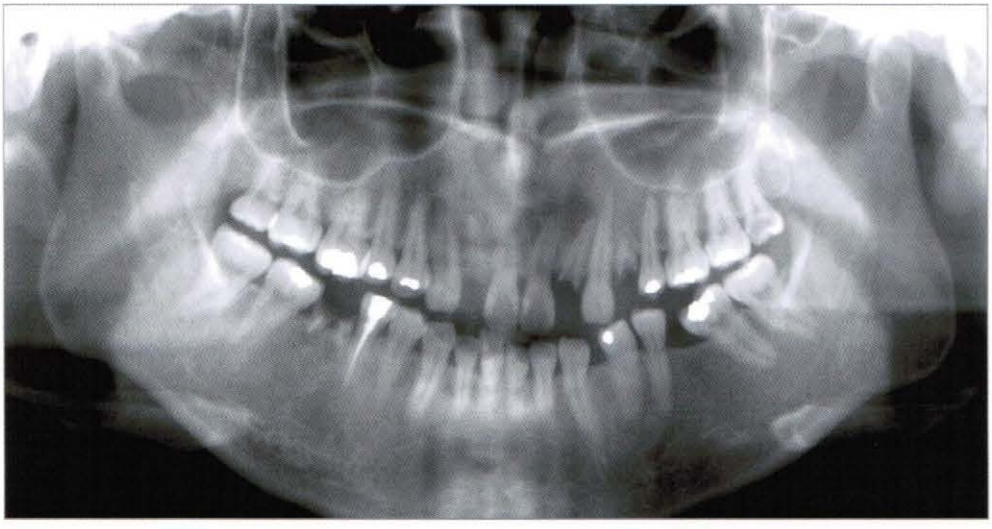


Figure 8-2-1. Panoramic radiograph on first visit to the Dental Hospital (2005. 12.8)
Left and right upper lateral incisors, left first premolar, and lower right first molar needed extraction of retained roots. Because the lower left second molar had tilted after loss of the first molar, uprighting was required for any prosthodontic treatment.

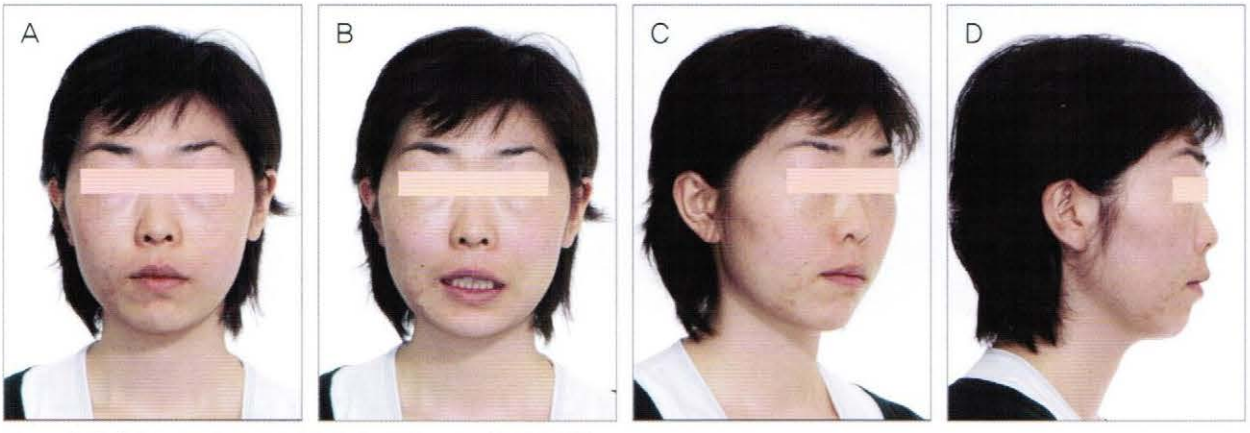


Figure 8-2-2. Pre-treatment facial photo of Case 15 (2006. 2.16)
She does not show her teeth during smile due to the multiple missing teeth. The profile is good and the patient has no complaints.

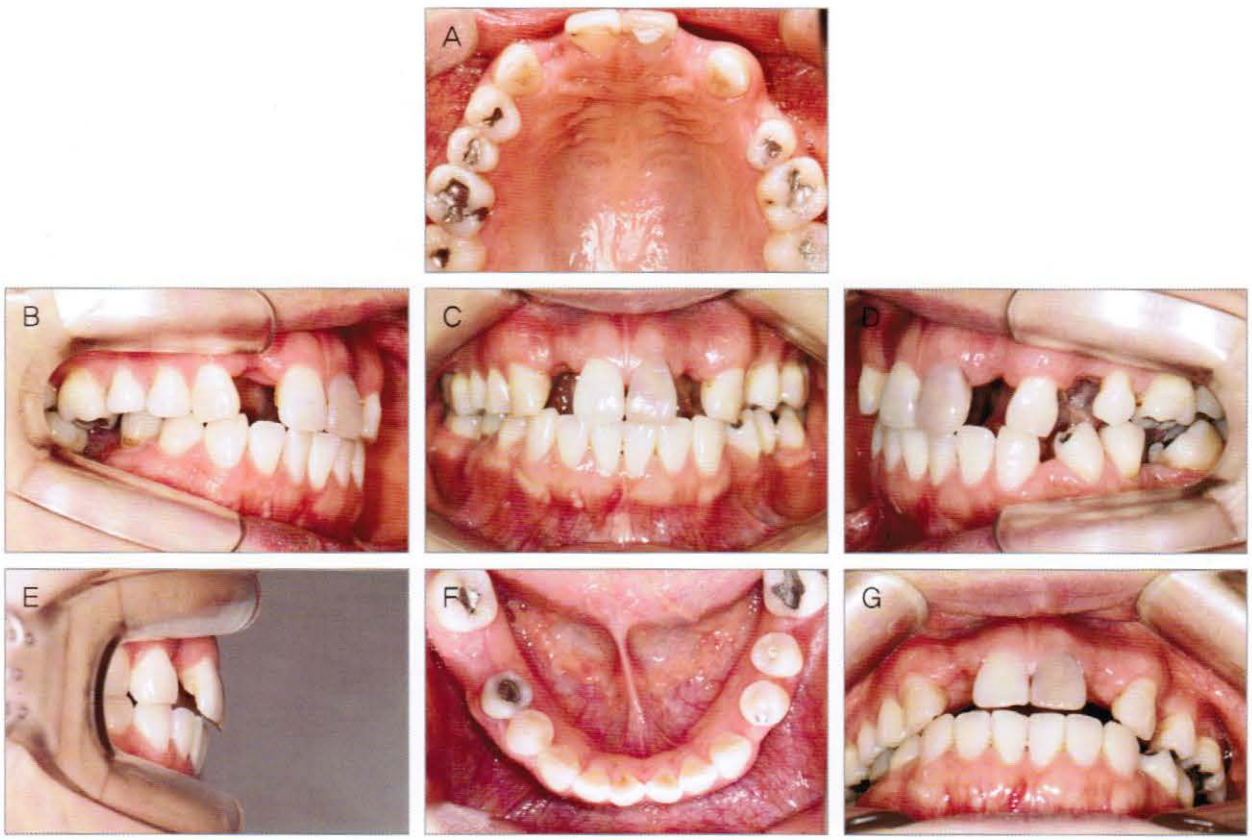


Figure 8-2-3. Pre-treatment intraoral photographs of Case 15 (2006. 2.16)
All the retained roots were extracted prior to orthodontic treatment. The lower left first and second premolars have rotated with spacing, due to distal drifting into the missing first molar space. The second molar of the same side shows severe tilting. A temporary removable appliance is being used for temporary space maintenance.

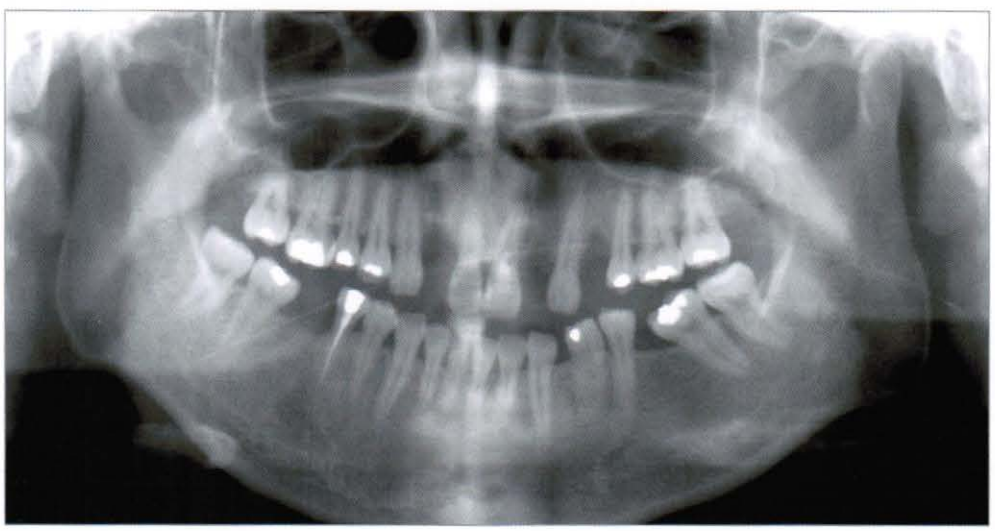
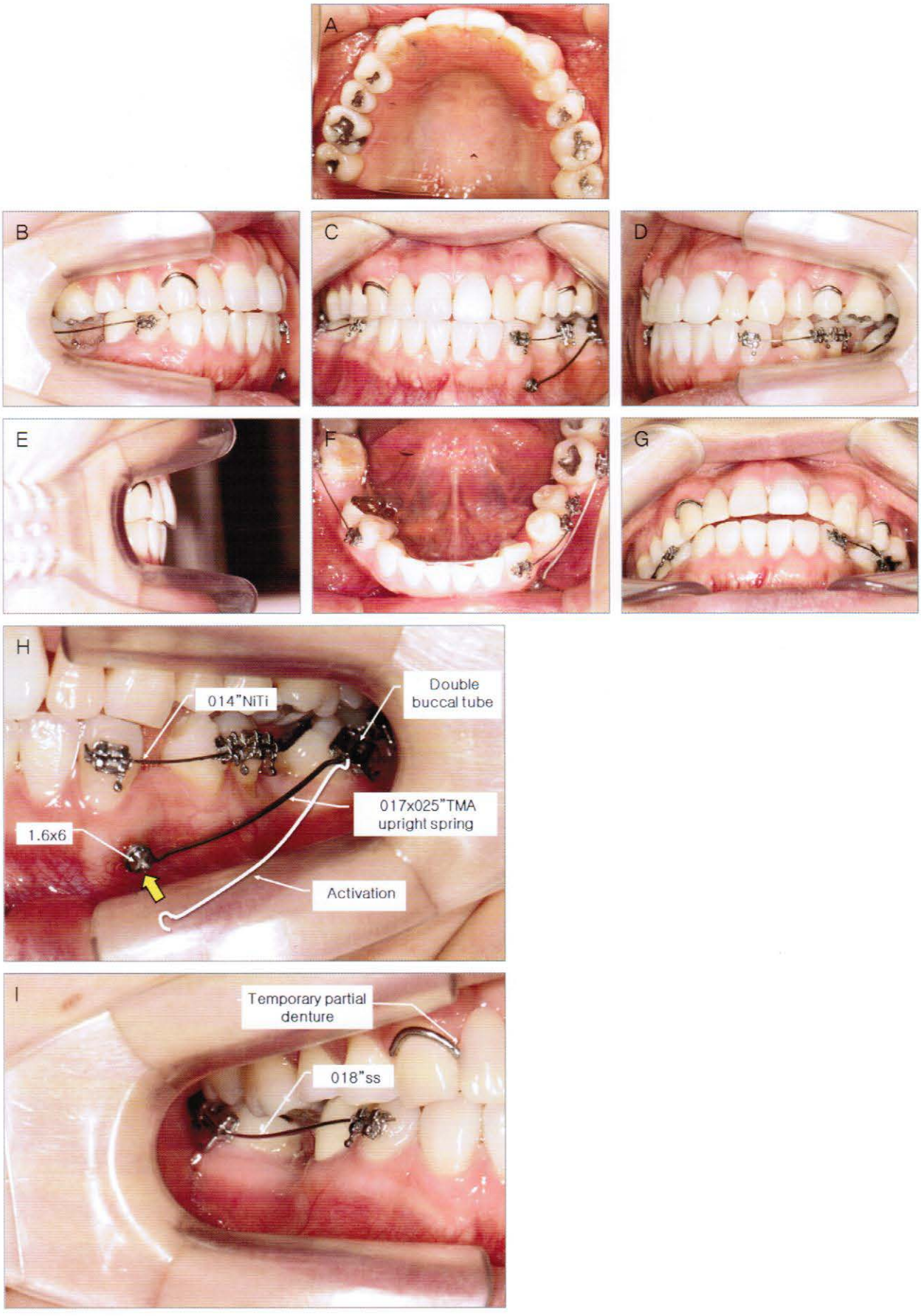


Figure 8-2-4. Pre-treatment panoramic radiograph. All the retained roots have been extracted. The lower left second molar is mesially tilted. The lower right second molar shows slight mesial tilting.

Treatment Progress

- **Fixed retainer**
  - 2006. 4.7 |67
  - 2006. 5.3 8+3
- **Implantation**
  - 2006. 5.17 Distal to |3, Labial 1.6×6.0 1EA
    Boinding brackets on |34578 + 014″ NiTi
- **Molar uprighting of |7**
  - 2006. 5.24 017×025″ TMA molar uprighting spring
  - 2006. 6.20 Bonding brackets on 7 4| +018″ ss
  - 2006. 7.25 016″ NiTi on |34578
    + Activation of molar uprighting spring (017×025″ TMA) in accessory tube of |7
- **Space regaining of |6**
  - 2007. 10.10 Removal of uprighting spring
    Bonding of 018×022″ ss wire segment on mini implant head and |3
    018″ss + open coil spring between |5 & |7
    + power chain between |3 & |4
- **Detailing**
  - 2006. 11.28 Bracket bonding on |3 + 016″ NiTi for uprighting of 7|
  - 2007. 1.10 019×025″ TMA on 743| & |34578
  - 2007. 3.16 Fixed retainer on 76|
    018×025″ ss on 743| & |34578
  - 2007. 4.22 019×025″ ss on 743| & |34578
    Refer to Dept of Prosthetics


A
B
C
D
E
F
G
H
014"NiTi
Double buccal tube
017x025"TMA upright spring
1.6x6
Activation
I
Temporary partial denture
018"ss

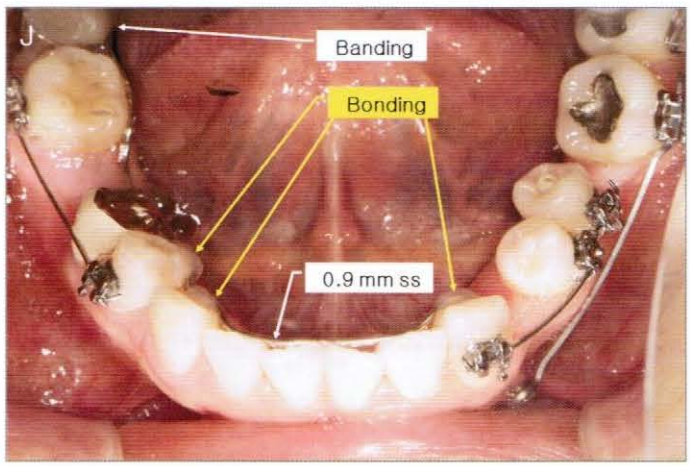


Figure 8-2-5. One month after lower right second molar uprighting (2006. 6.20)

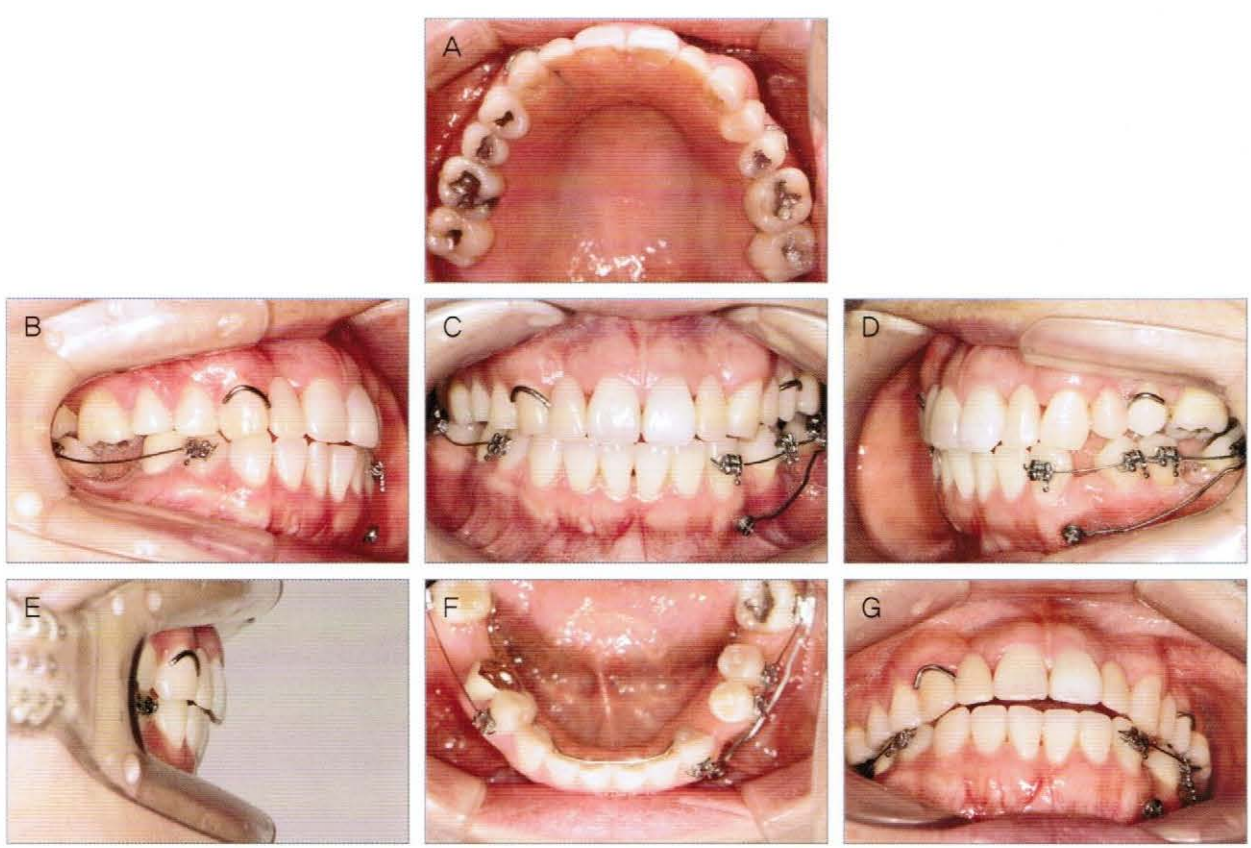
A. No appliances were bonded in the upper arch. The temporary upper partial denture can be seen. A fixed retainer has been bonded on the lingual surface of the upper left first and second molars to prevent extrusion of the first molar.

C. A mini-implant (1.6×6.0mm) has been inserted distal to the lower left canine root.

H. Appliances in the lower right quadrant
022″ MBT brackets are bonded from canine to second premolar, with double buccal tube bonded on the second molar. 017×025″ TMA was used to construct an uprighting spring. After activation as shown in the photograph, it was hooked onto the mini-implant head (1.6×6.0mm).

I. Appliances in the lower left quadrant
Brackets were bonded on the first premolar and first molar, with 018″ ss wire ligated.

J. Appliances in the lingual side of the lower arch
For anchorage re-inforcement, 0.9mm ss lingual arch was bonded on the lower right first premolar and left canine, and attached to a band on the lower right third molar.



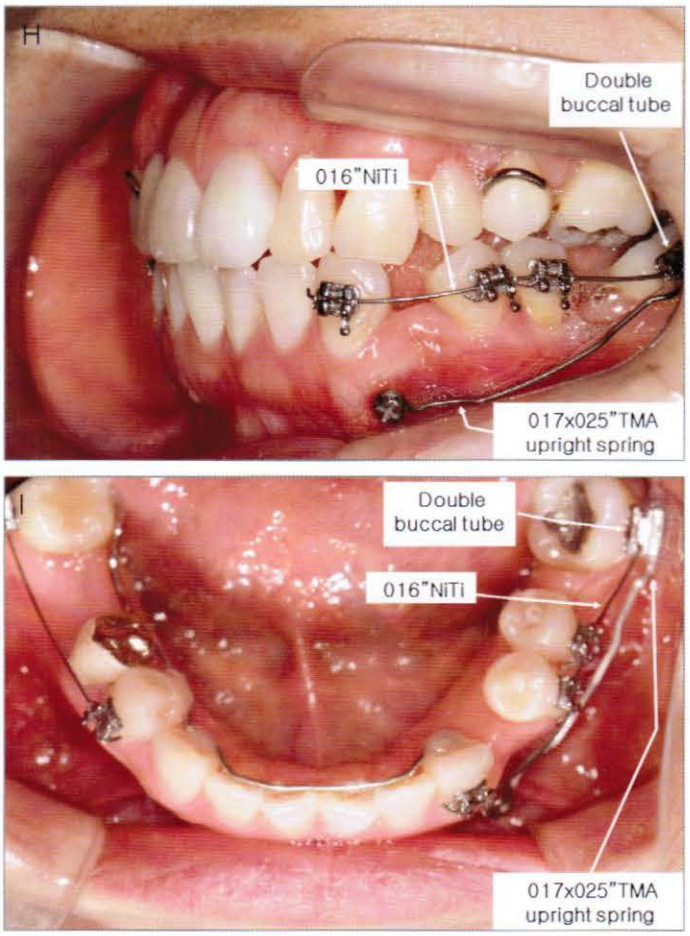
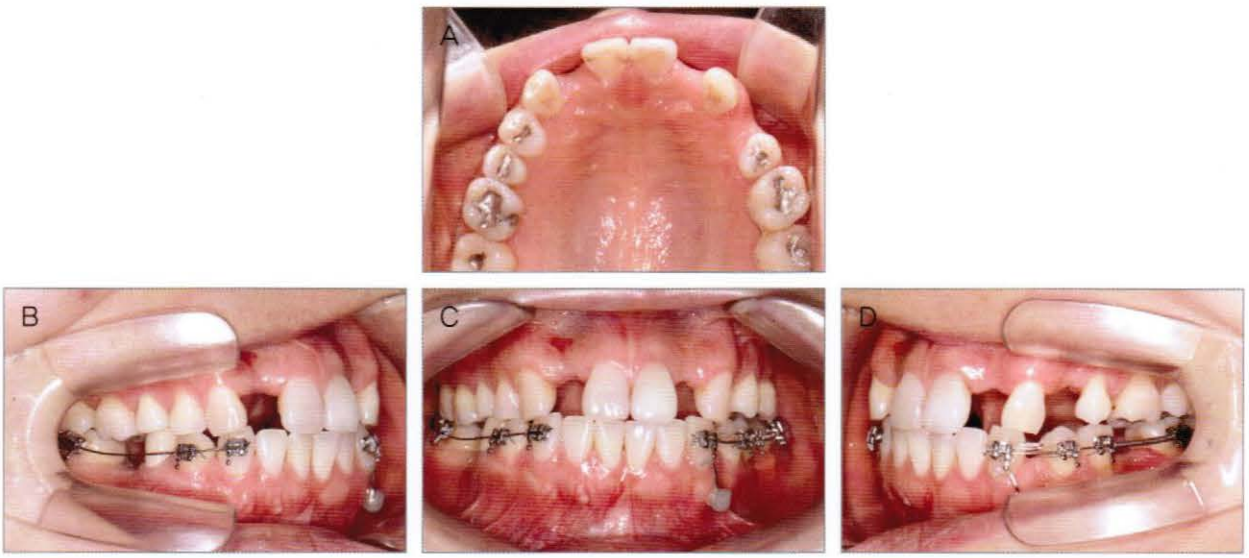


Figure 8-2-6. Two months into uprighting of lower right second molar (2006. 7.25)
H, I. A 016" NiTi wire was inserted into the main tube of the double buccal tube of the lower left second molar band. 017×025" TMA uprighting spring was inserted into the accessory tube of the second molar band.



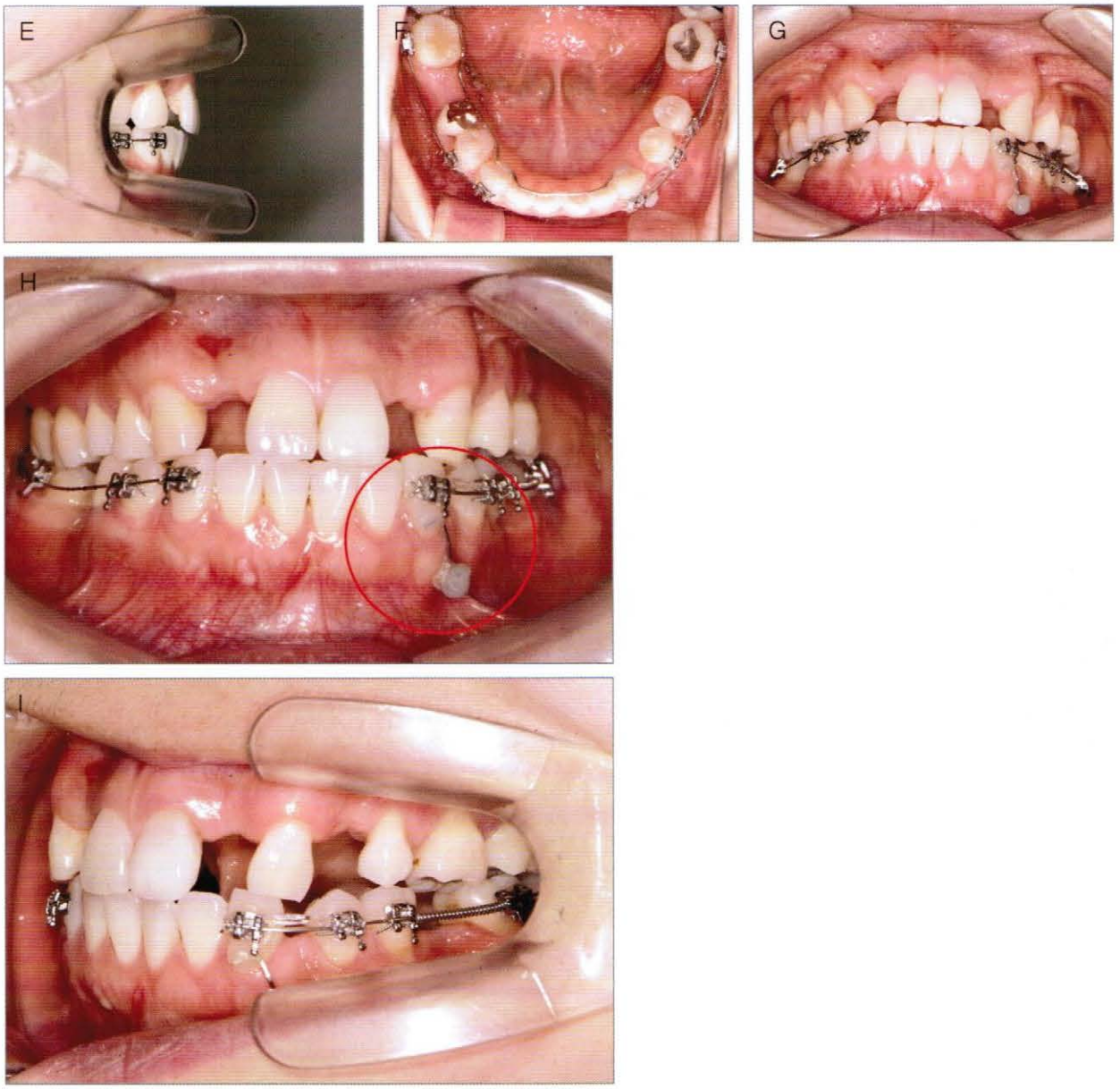


Figure 8-2-7. Six months into uprighting of lower right second molar (2007. 11.28)
The 017×025″ TMA uprighting spring has been removed (D). A bracket has been bonded onto the lower right canine. This is because the lingual bonding on the adjacent first premolar had debonded (F). The canine was bracketed and because it is bonded lingually to the lingual wire, it was used as additional anchorage for molar uprighting (C).
H. 016″ NiTi was ligated to the third molar. 018×022″ ss wire segment was bonded from the lower left canine to the mini-implant head.
I. Power chain was used between the canine and second molar for space closure. Open coil spring between the second premolar and second molar is being used to regain space for the first molar.

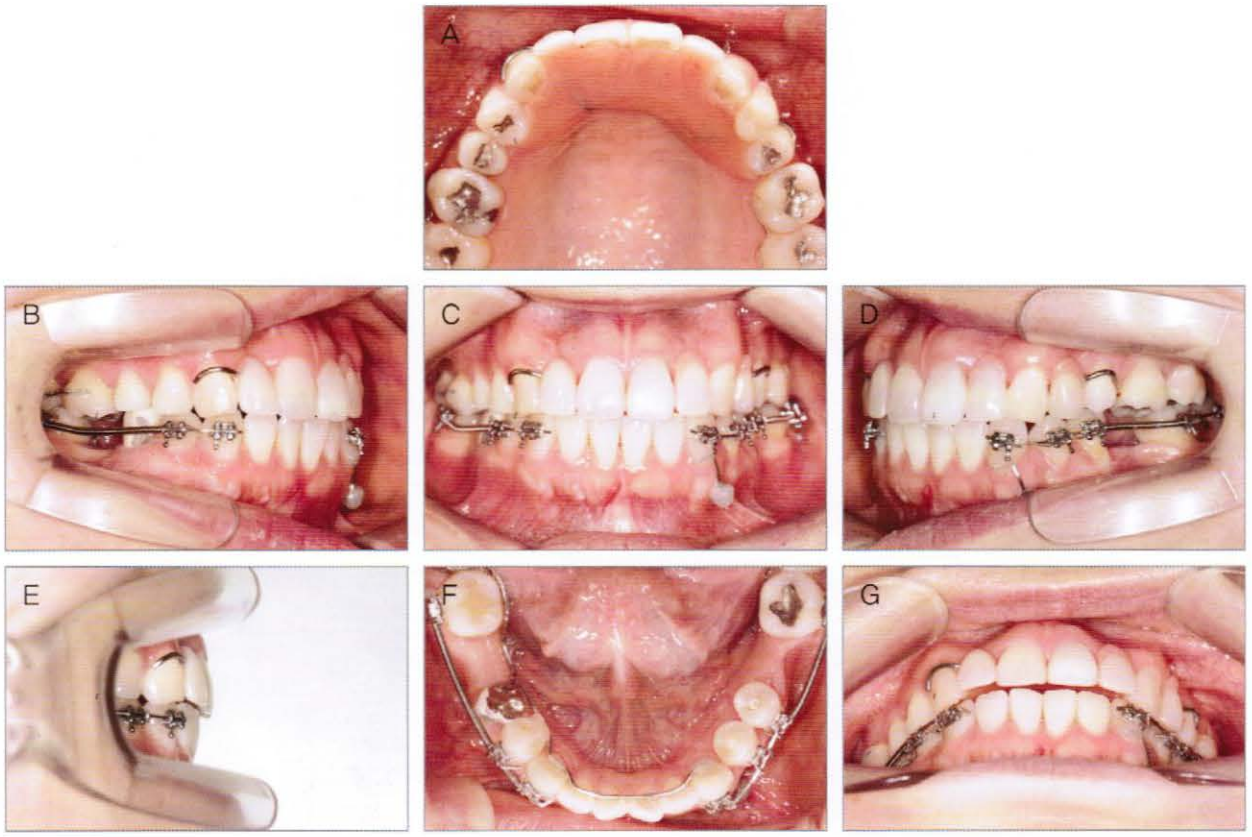
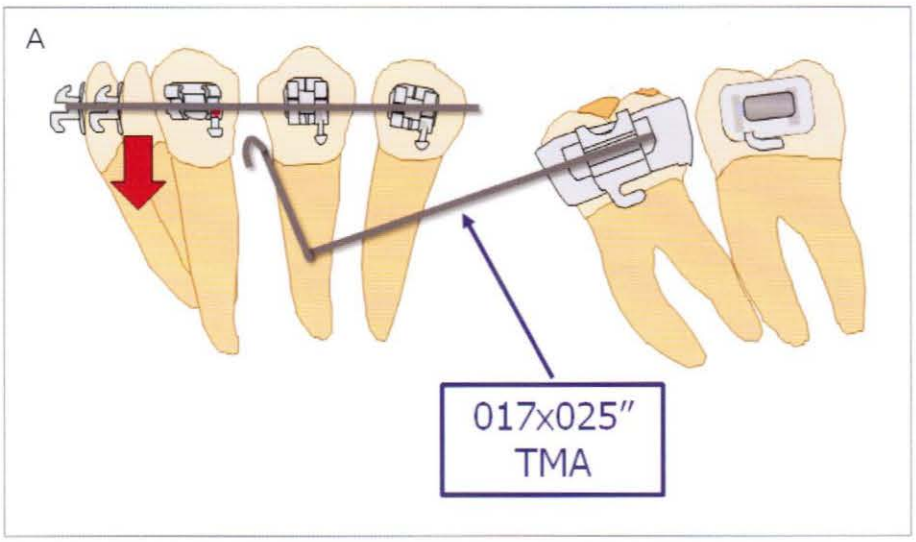


Figure 8-2-8. Intraoral photograph after finishing treatment for referral to Prosthodontic department (2007. 4.22)
The patient was referred in this condition.
A, B, C. Upper partial denture was continued to be used. The patient finished orthodontic treatment without esthetic complaints. Fixed retainer has been added on to the buccal surfaces of the upper right first and second molars to prevent extrusion.
F. Closed coil spring is being used between the lower left second premolar and second molar to maintain space.



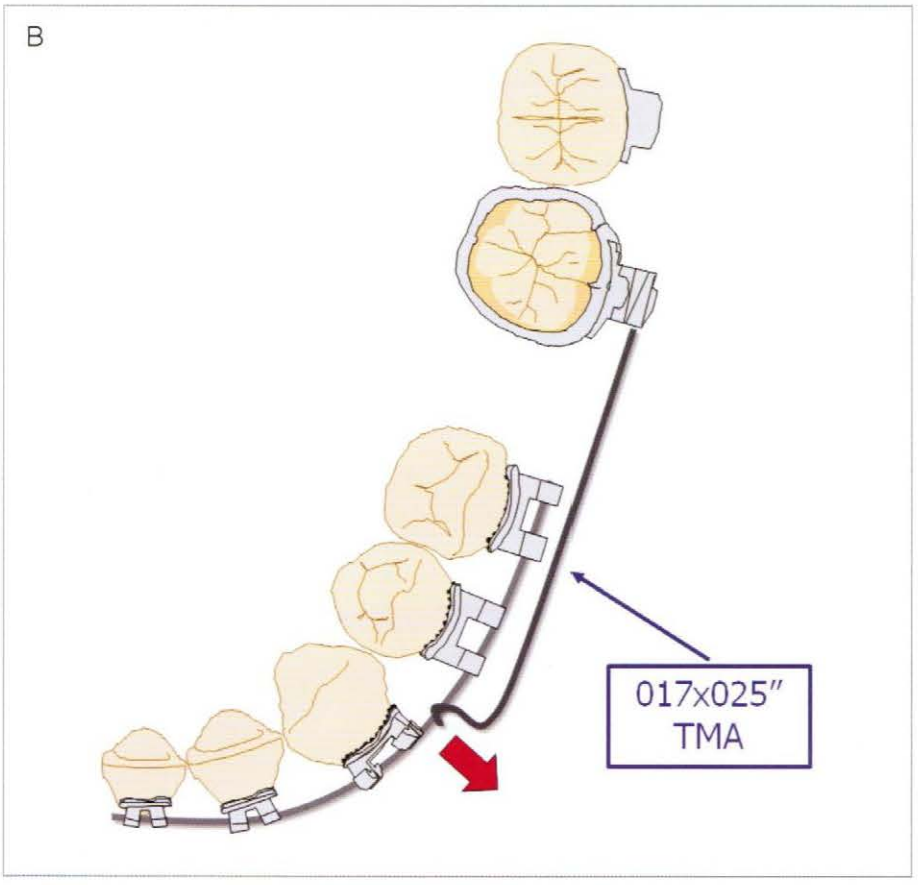
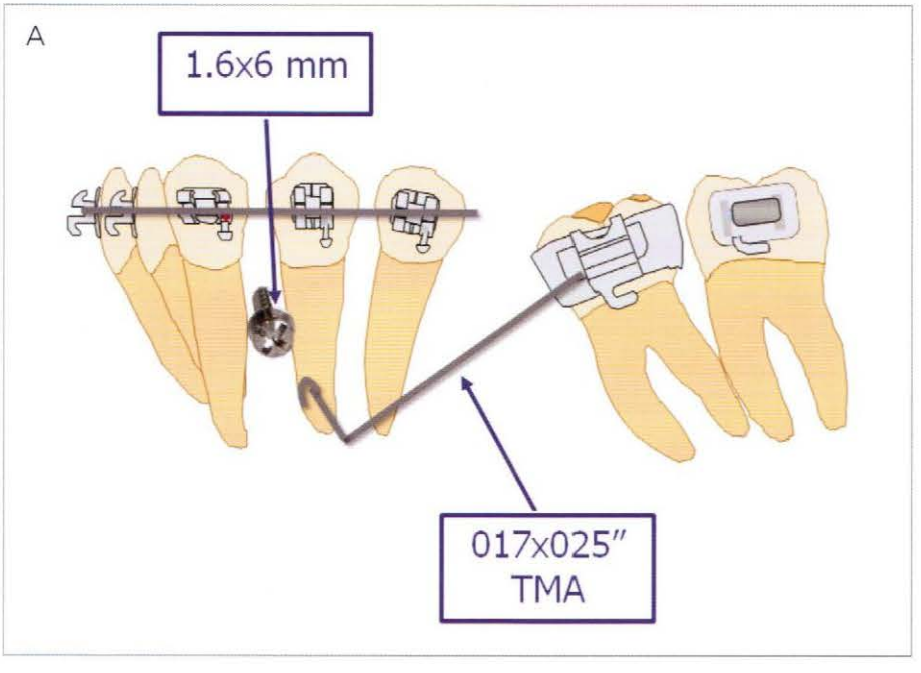


Figure 8-2-9. Side effects when traditional uprighting spring is used
A. Anterior teeth receive intrusive force (arrow). Occlusion will be disrupted generally.
B. Because the anchor teeth receive intrusive force through the buccally bonded brackets, they will receive buccal or labial force (arrow).



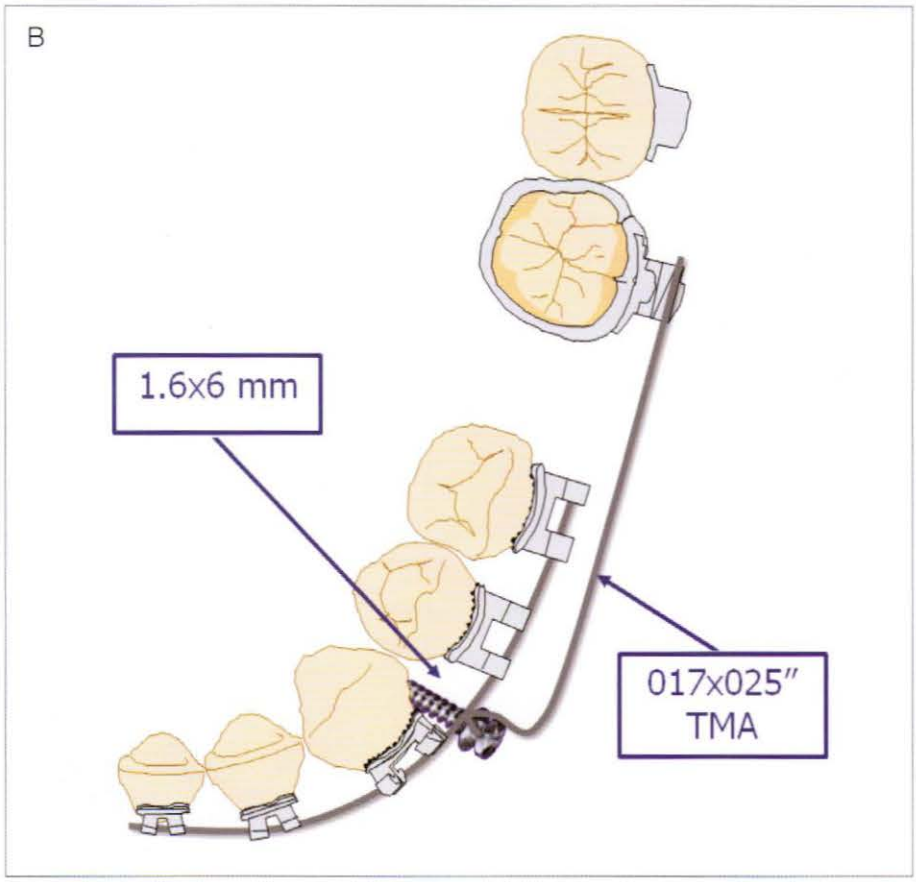


Figure 8-2-10. Mechanics with mini-implant use
A, B. Because anchorage is received through the mini-implant, the anterior teeth are not affected.

Ⅲ. Missing molar

Cases with complex problems which were treated with original ideas throughout each step will be explained. The next case shows treatment of missing molars treated through orthodontic treatment only.

■ Case 16 (Figure 8-3-1 to 22)

- Age : 21 years 5 months
- Sex : female
- Chief complaint : open bite

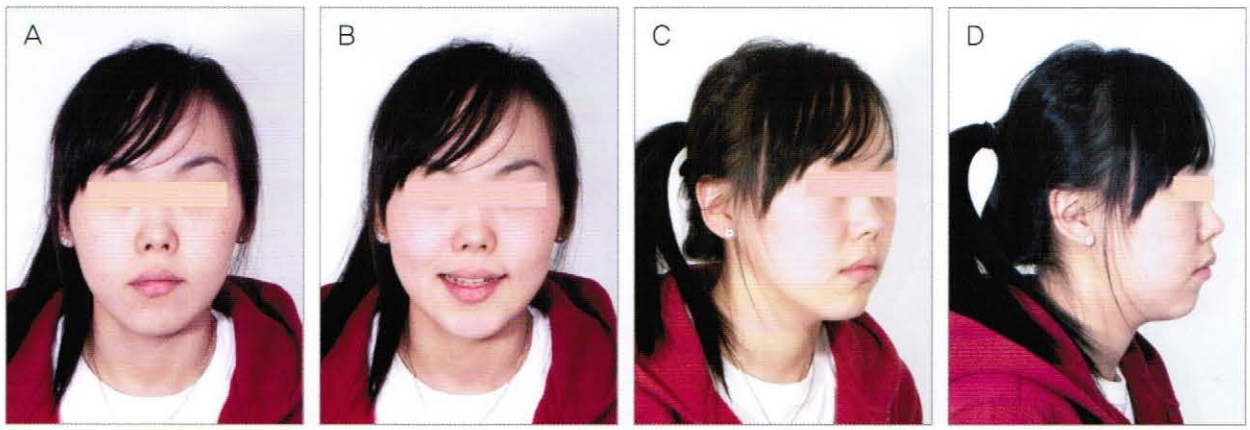


Figure 8-3-1. Pre-treatment facial photograph of Case 16 (2005. 3.9)
She shows mouth protrusion. There is open bite but no lip incompetency.
A. The face is relatively symmetrical.
B. She does not smile with confidence due to the irregular and missing teeth.
C, D. The mouth is protruded with retrusion of the chin.

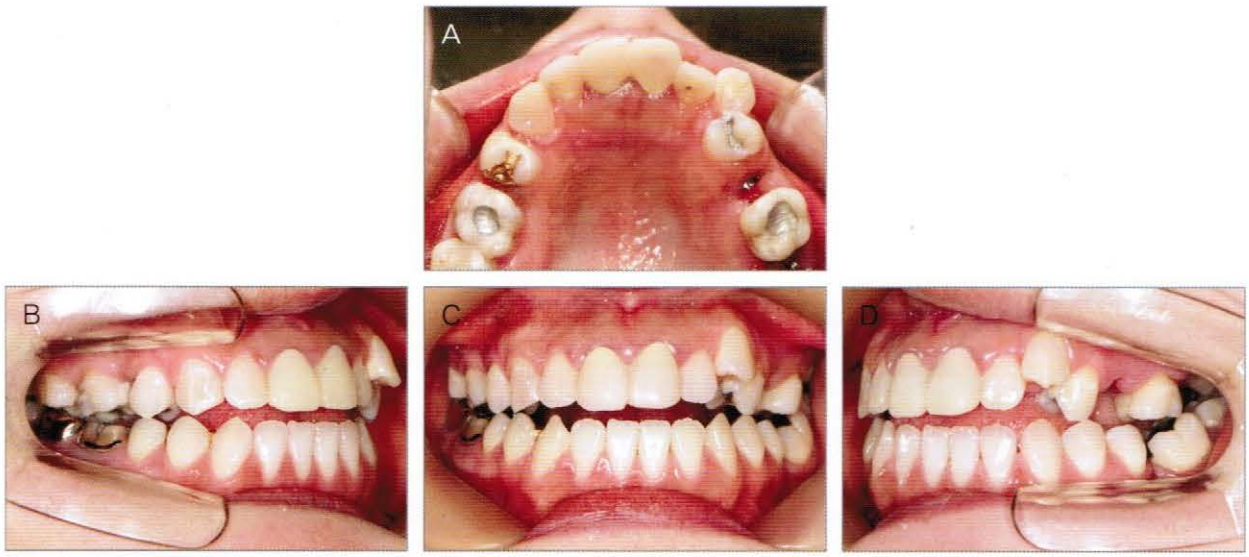
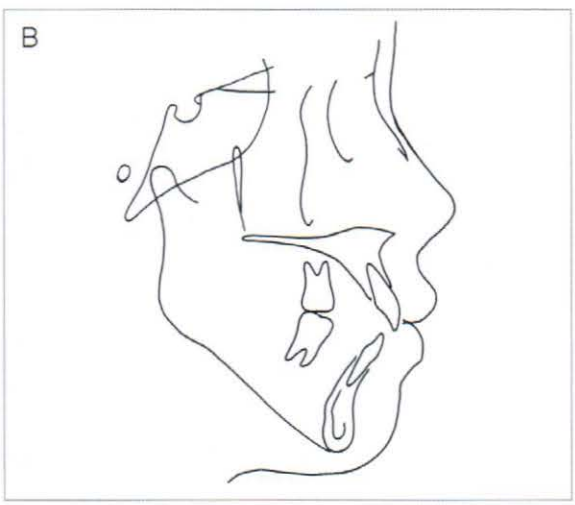


Figure 8-3-2. Pre-treatment intraoral photograph of Case 16 (2005. 3.9)
There is severe open bite (C). Teeth 15, 25, 27 and 36 are missing. This has caused the upper right first molar and lower left second molar to tilt mesially (B, F).



C

	Norm	SD	T1
SNA	81.6	3.2	79.3
SNB	79.2	3.0	74.5
ANB	2.5	1.8	4.8
FMA	24.3	4.6	41.0
ODI	72.0	5.5	62.1
U1 to FH	116.0	5.8	112.4
IMPA	95.9	6.4	84.2
IIA	123.8	8.3	122.3
Esth-U	- 0.9	2.2	3.6
Esth-L	0.6	2.3	3.5

Figure 8-3-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C) (2005. 2.28)
A, B. She shows characteristics of skeletal Class II open bite.
C. With an ANB angle of 4.8°, and APDI of 78.8°, the antero-posterior relationship is skeletal Class II. Vertically, Björk sum of 411.1°, FMA of 41.0° and ODI of 62.1° shows a skeletal open bite pattern.

Figure 8-3-4. Postero-anterior radiograph (2005. 2.28)
No asymmetry noted.

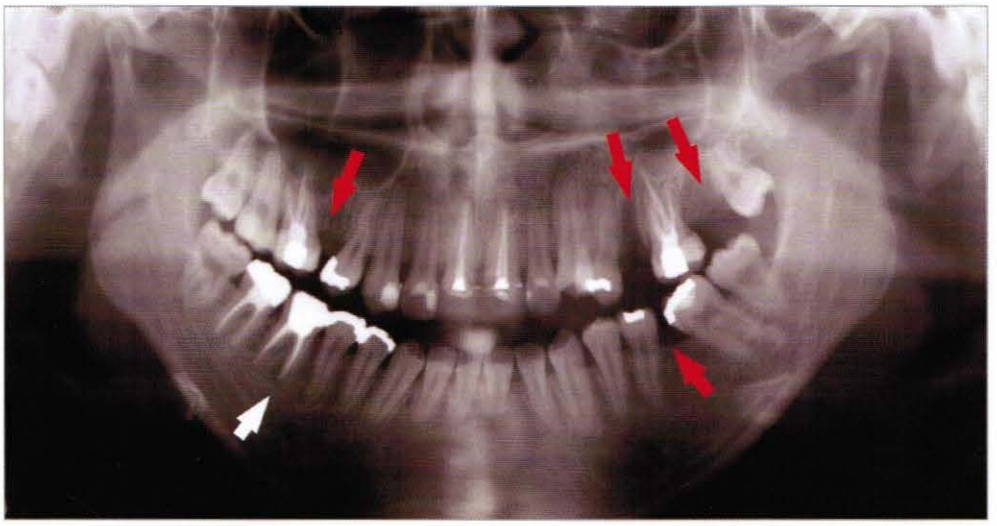


Figure 8-3-5. Pre-treatment panoramic radiograph (2005. 2.28)
Tooth number 15, 25, 27, and 36 are missing (red arrow). This has caused the upper right first molar and lower left second molar to be tilted mesially. The lower right first molar mesial root shows a periapical radiolucency at the root tip (white arrow).
The mandibular condyle size is very small. The right side is especially small and idiopathic condylar resorption is suspected.

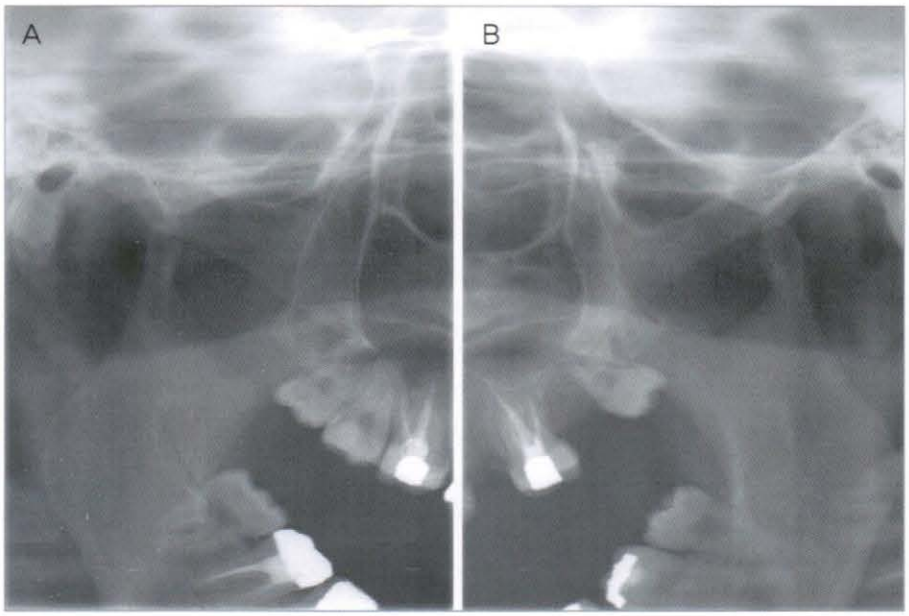


Figure 8-3-6. Pre-treatment TMJ panoramic radiograph (2005. 2.28)
The mandibular condyle is small, especially the right side. In these cases, MRI and bone scan should be taken. The patient in this case did not complain of pain or discomfort.

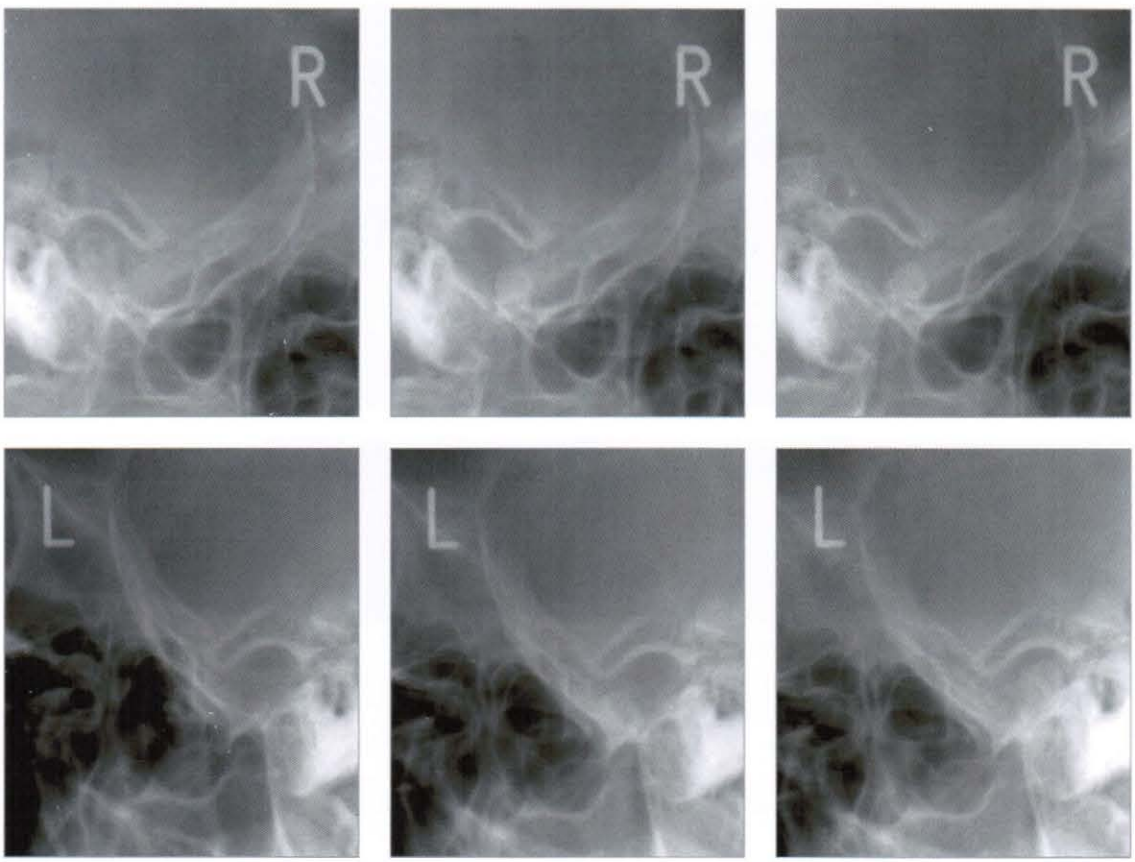


Figure 8-3-7. Transcranial radiograph (2005. 2.28)
Mandibular condyle movement is normal. There is no clicking during mandibular movement.

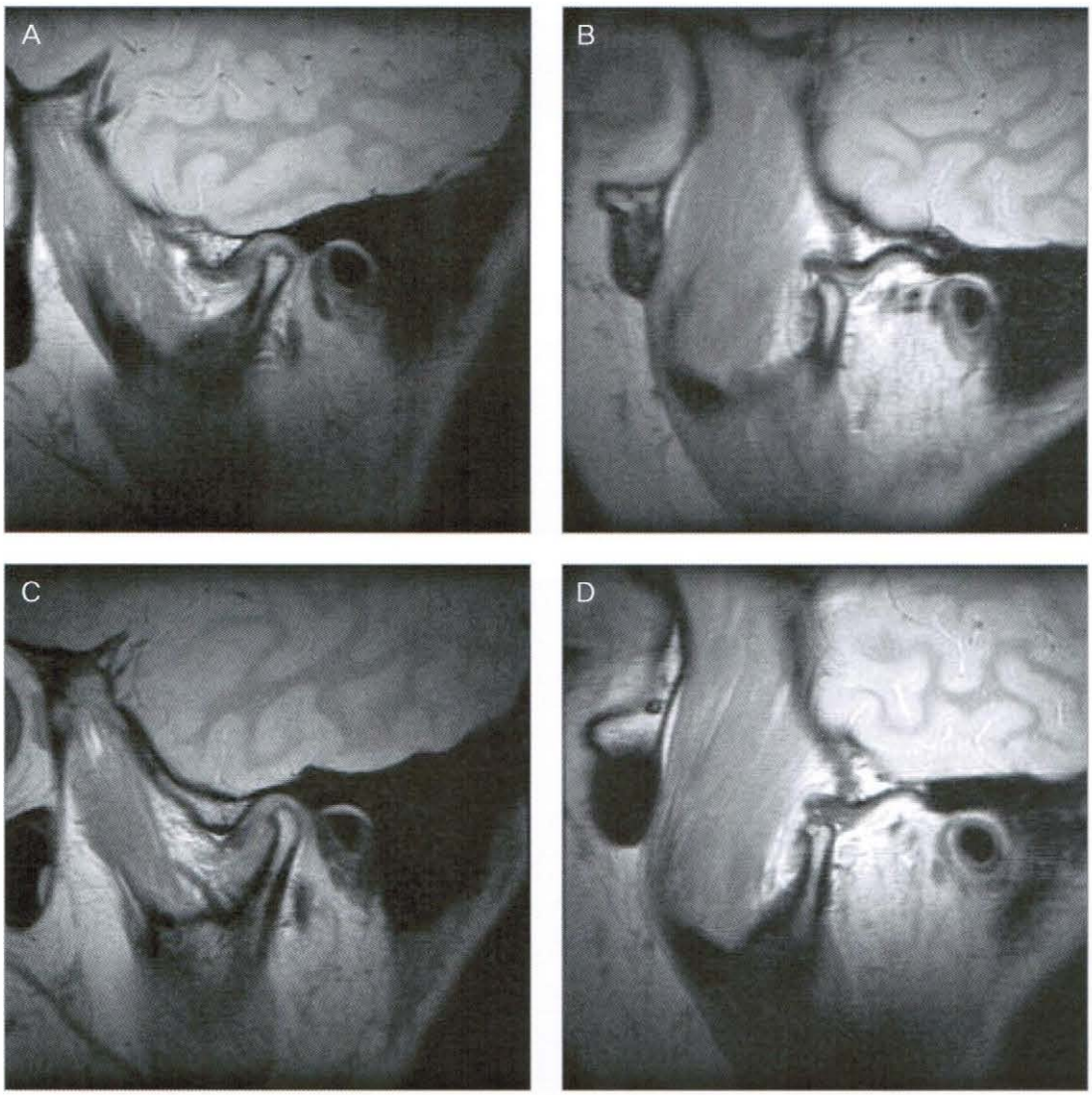


Figure 8-3-8. MRI (2005. 4.22)
A. Right closed state, B. right maximal open state, C. left closed state, D. left maximal open state
Both joints showed ADD without reduction. With this type of disk displacement the patient shows no symptoms at present, but if the disk is thinned any more or pain arises due to inflammation, Class II open bite may relapse after orthodontic treatment. This must be fully explained to the patient and written consent received prior to treatment to prevent possible legal disputes in the future (refer to Clinical tip).

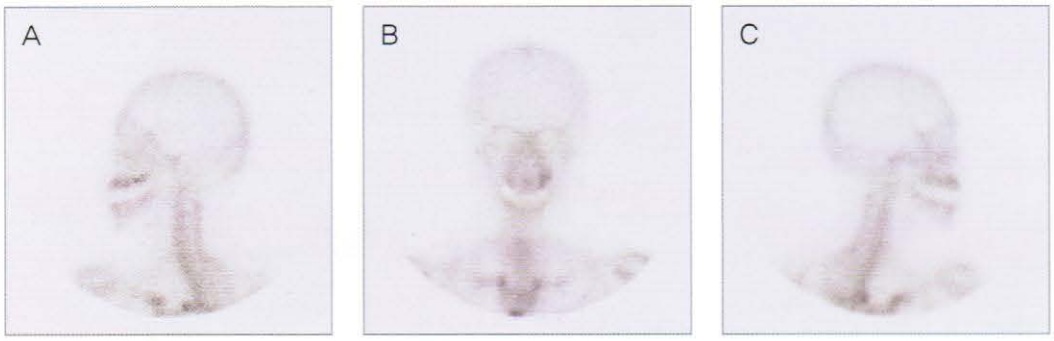


Figure 8-3-9. Pre-treatment bone scan (2005. 5.4)
There are no active lesions in both TMJs. There is inflammation of the upper gingiva.

Clinical tip ››››

Treatment of patients with idiopathic condylar resorption

1. Suspect the presence of TMJ disorder in Class II open bite patients. Around 70% will show disk displacement.
2. In these patients occlusal changes, and skeletal and facial changes may occur according to the state of TMJ disorder, regardless of orthodontic treatment.
3. When active lesion is evident on bone scan, changes in the joint can be expected. It must be explained prior to treatment that the result of orthodontic treatment may be affected by the state of the joints.
4. Idiopathic condylar resorption occurs mainly in growing female adolescent patients. Sometimes active lesions can be seen in post-pubertal patients, and can progress to Class II open bite.
5. Take plenty of time for detailing, or after orthognathic surgery. Place up & down elastics for retention. This period can be used to obtain better interdigitation, and allow the muscles and soft tissues to adjust.
6. If there were no TMJ symptoms prior to orthodontic treatment, there are no indicators to assess whether TMJ disorder will arise during orthodontic treatment.
7. When the TMJ symptoms subside and are stabilized, the patient is advised to improve general health, minimize stress and tiredness, and to get plenty of sleep. Medications which help suppress progression of degenerative joint disease, such as antioxidant, vitamin C, glucosamine, and condroitin are recommended.
8. The patient is advised to visit the department if the joint disease relapses, even after orthodontic treatment has finished.

References

- Sug-Joon Ahn, Tae-Woo Kim, Dong-Seok Nahm, Cephalometric keys to internal derangement of temporomandibular joint in women with Class II malocclusions, Am J Orthod Dentofac Orthop 2004;126:486-95.
- Hoon Jung, Tae-Woo Kim et al. Treatment of Temporomandibular Joint Disorder : Clinical cases, 16-38, Narae, 2008.

Treatment Progress

- **Leveling** — 5 months
  - 2005. 6.17 — 014″ NiTi
  - 2005. 7.15 — 018″ NiTi
  - 2005. 8.5 — 016×022″ NiTi
  - 2005. 9.13 — 017×025″ NiTi
  - 2005. 10.4 — U : 018×022″ ss with shoe hooks
    L : 018×022″ ss with shoe hooks
- **Implantation**
  - 2005. 11.1 — 1.6×6.0 — 2EA — $\frac{\lfloor 4 \downarrow}{4 \uparrow 5}$
- **Space closing** — 11 months
  - 2005. 11.1 ~ 2006. 10.4 — Power chain from mini-implants to left upper and lower third molars + U/D 3/16″ 6Oz elastics
- **Detailing**
  - 2006. 10.4 — Removal of mini-implants
    L : 018″ NiTi + 1/4″ 6Oz Box elastic on the left posterior area
  - 2006. 11.10 — L : 016×022″ NiTi + Expanded TPA
  - 2006. 12.20 — L : 018×022″ ss with shoe hooks + Class I elastics 5/16″ 6Oz + U/D 3/16″ 6Oz Removal of TPA
  - 2007. 1.17 — L : MEAW (018×022″ ss) + U/D 3/16″ 6Oz elastics
- **Debonding**
  - 2007. 8.14

Total 26 months

This case presents with 4 missing teeth and Class II open bite. All the spaces were closed orthodontically and open bite has been treated. After leveling, periapical radiographs were taken, and 1.6x6.0mm mini-implants inserted between the relatively wide interradicular space between the lower first and second premolar, and distal to the upper left first molar. Space closure was fairly rapid in the upper arch, but obtaining parallelism in the lower arch took around a year. After space closure, the midline was coincident, and the incisors in an edge-to-edge relationship. The remaining open bite was closed with lower MEAW and up-and-down elastics for extruding the incisors. When the incisors are in an edge-to-edge bite, the open bite cannot be resolved through upper molar intrusion. Class III elastics were not used considering the ADD without reduction of the TMJ.

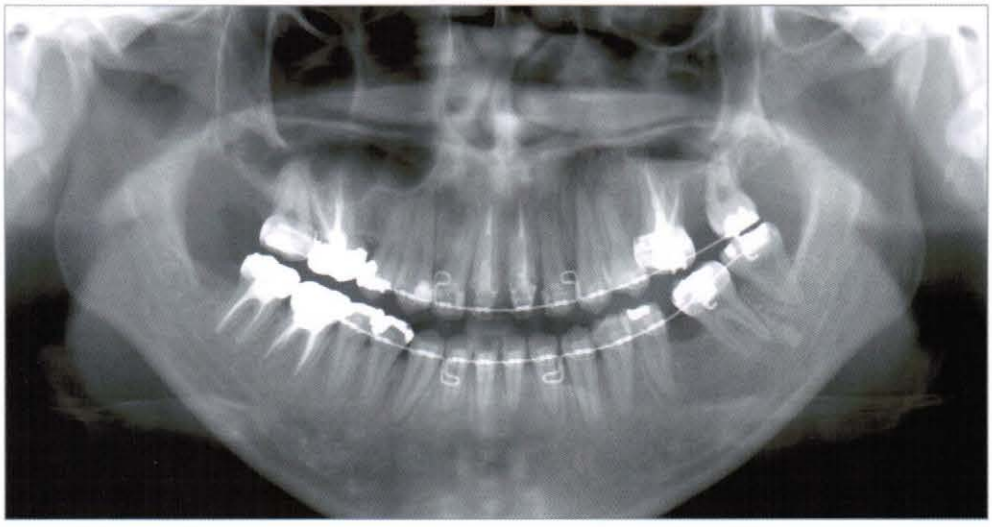


Figure 8-3-10. Panoramic radiograph taken after leveling (2005. 10.4)
018×022" ss wire with shoe hooks is ligated. Periapical radiograph was also taken. 1.6×6.0mm mini-implants were planned to be inserted between the lower first and second premolars, and distal to the upper left first molar. During leveling of the upper arch, the second premolar spaces closed naturally.

Figure 8-3-11. Space closing stage (2006. 4.6)
Power chain is placed between the mini-implant and upper third molar and lower second molar for forward protraction. Open bite has closed a fair amount during leveling. However as the lower left second molar is being uprighted, the lower left canine and premolar has intruded, causing open bite in this area. Upper space closure is complete. The rate of tooth movement of the lower arch is much slower than the upper arch.

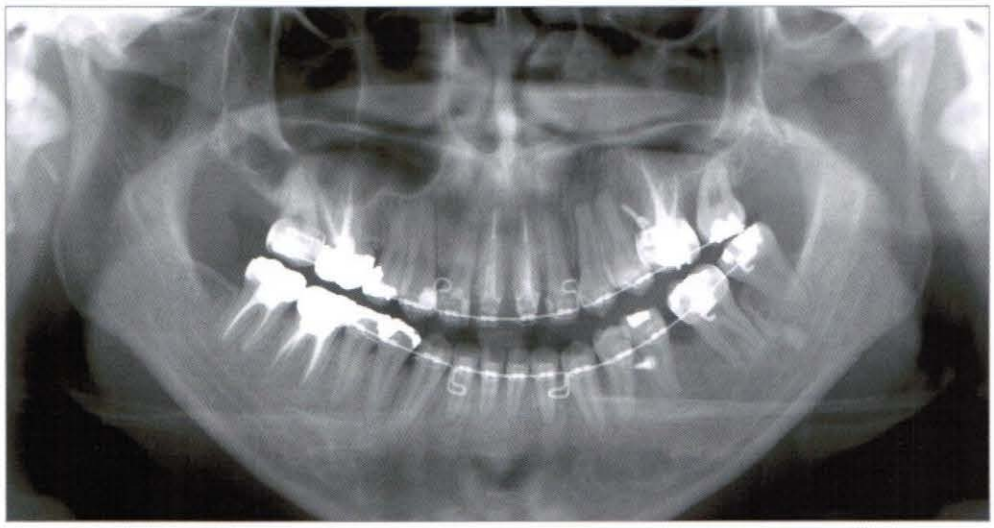


Figure 8-3-12. Panoramic radiograph at the space closing stage (2006. 4.6)
Upper 15, 25, and 27 spaces have been closed. If there is no pneumatization of the maxillary sinus, space closure is fairly rapid. Forward movement of the molars is especially fast in open bite patients. Mini-implant is inserted well and does not contact the roots.

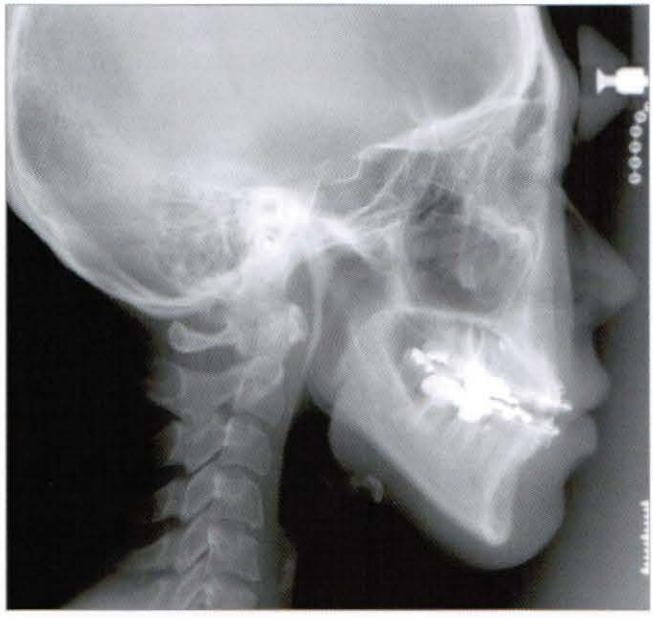


Figure 8-3-13. Cephalometric radiograph at the space closing stage (2006. 4.6)
Open bite has decreased due to up-and-down 3/6" 6 oz elastics being used between the upper and lower canines during the leveling stage.

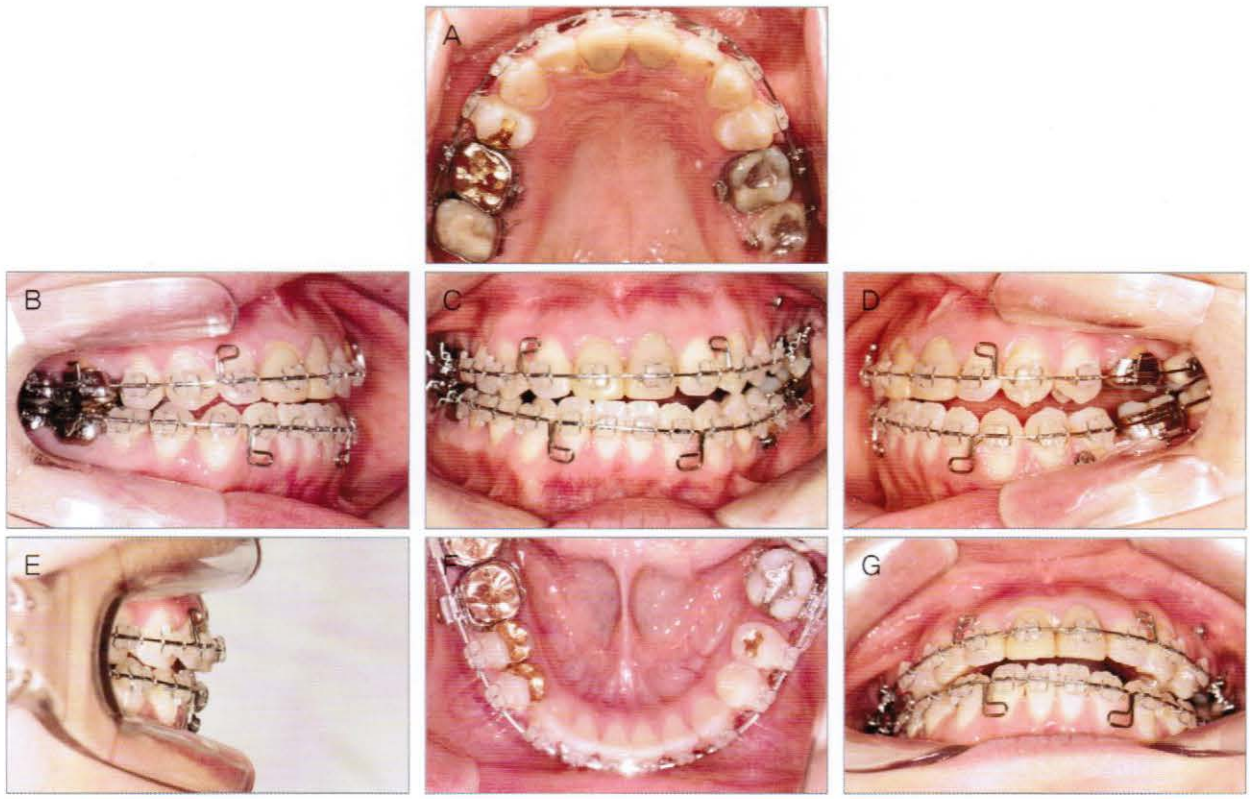


Figure 8-3-14. Extraction space closure stage (2006. 7.4)
With 018×022″ ss with shoe hooks in the upper arch, space is being closed through power chain between the mini-implant and the distal molars in both arches. Space closure is complete in the upper arch.

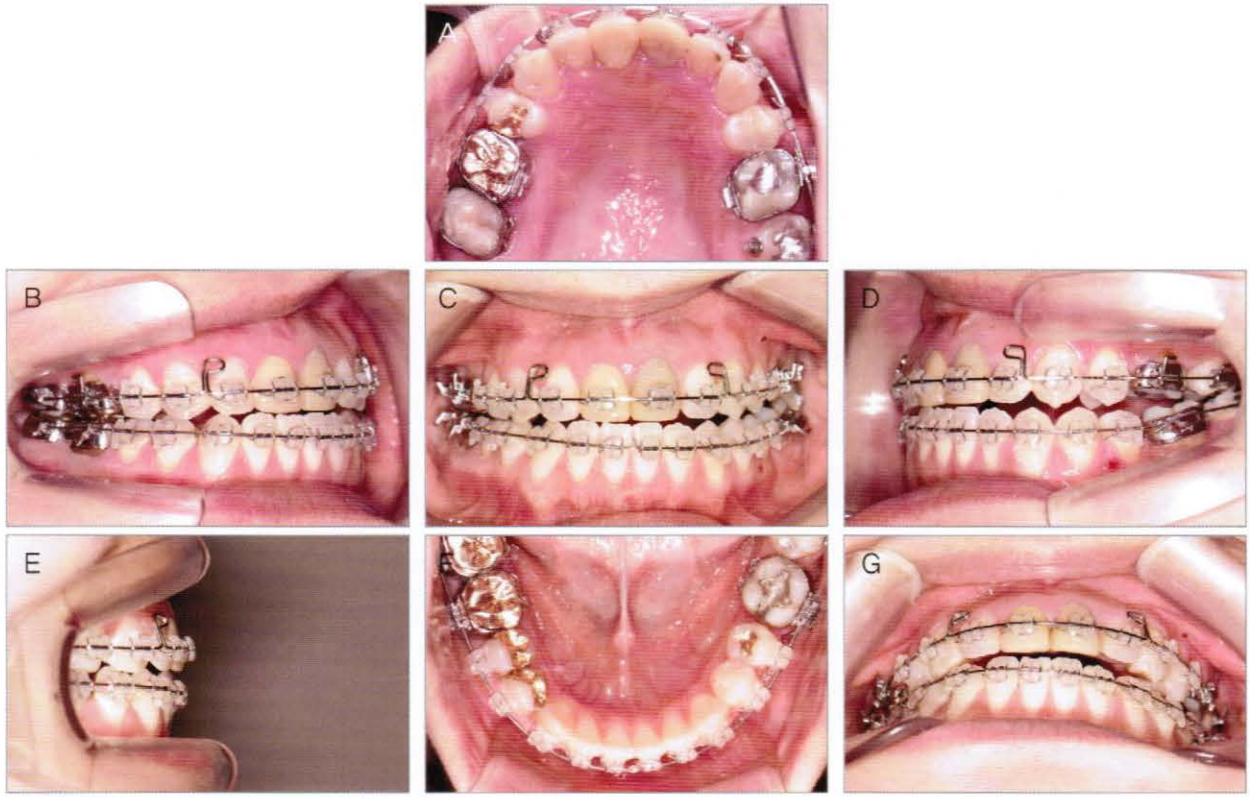


Figure 8-3-15. Completion of space closure (2006. 10.4)
Space closure for both arches took 11 months. All mini-implants were removed. Upper and lower second molar bands have been removed, and rebonded with brackets. 018″ NiTi is being used for re-leveling.

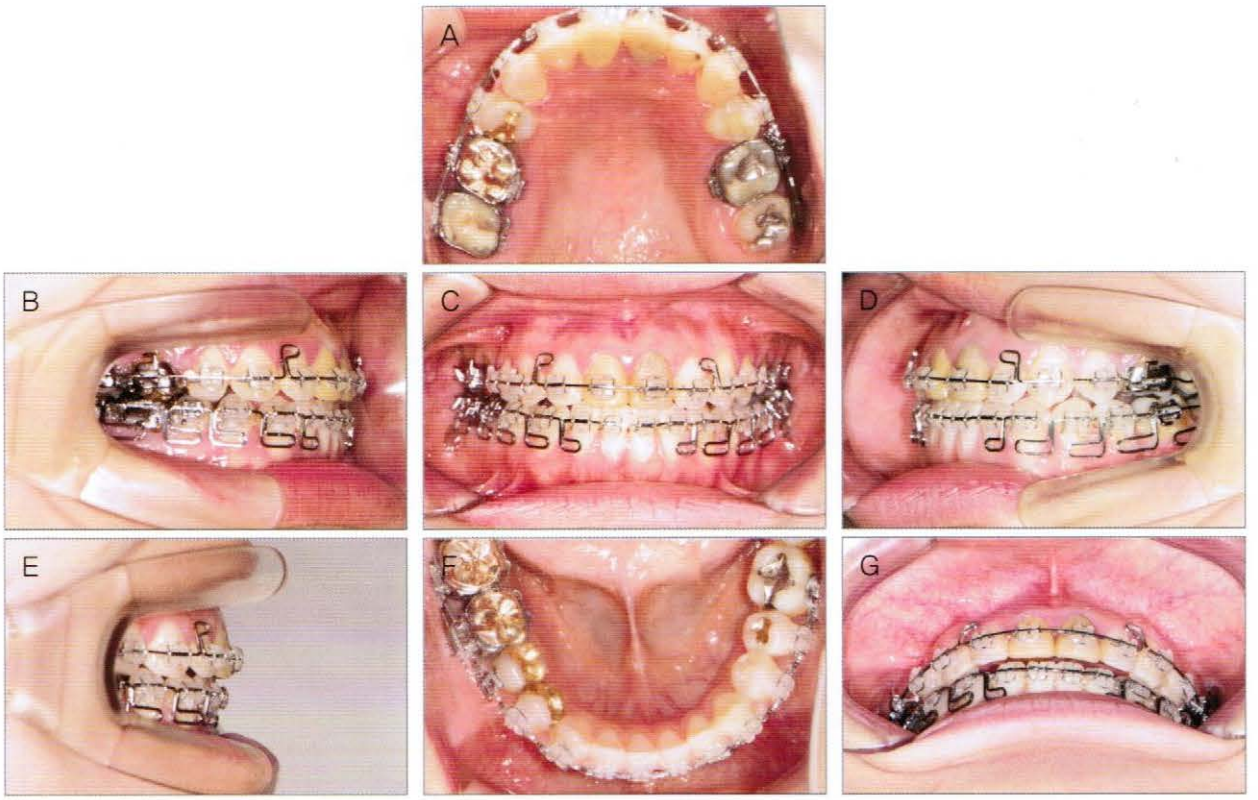


Figure 8-3-16. Detailing stage (2007. 6.9)
Lower MEAW (018×022" ss, Multiloop Edgewise ArchWire by Dr. Young H. Kim) is inserted, and up-and-down 3/16" 6 Oz elastics placed between the upper and lower most anterior L-loops to increase overbite.

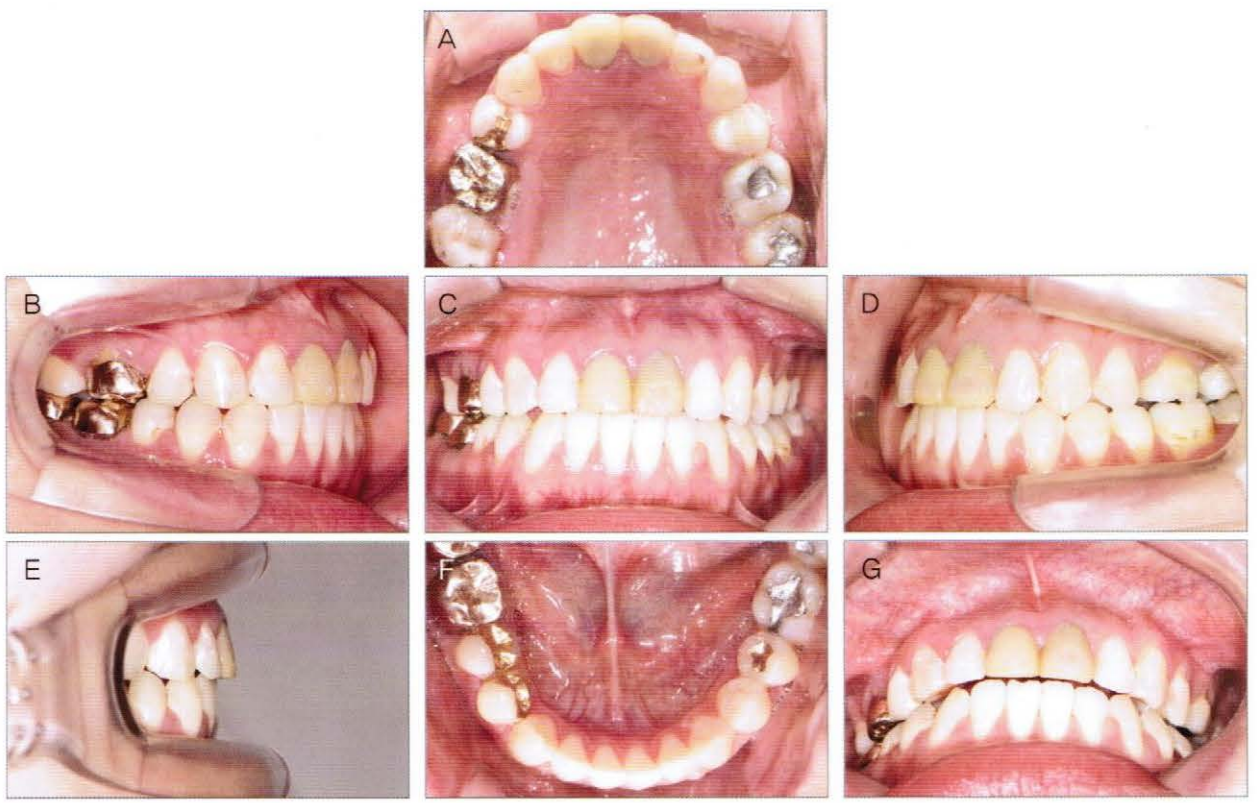
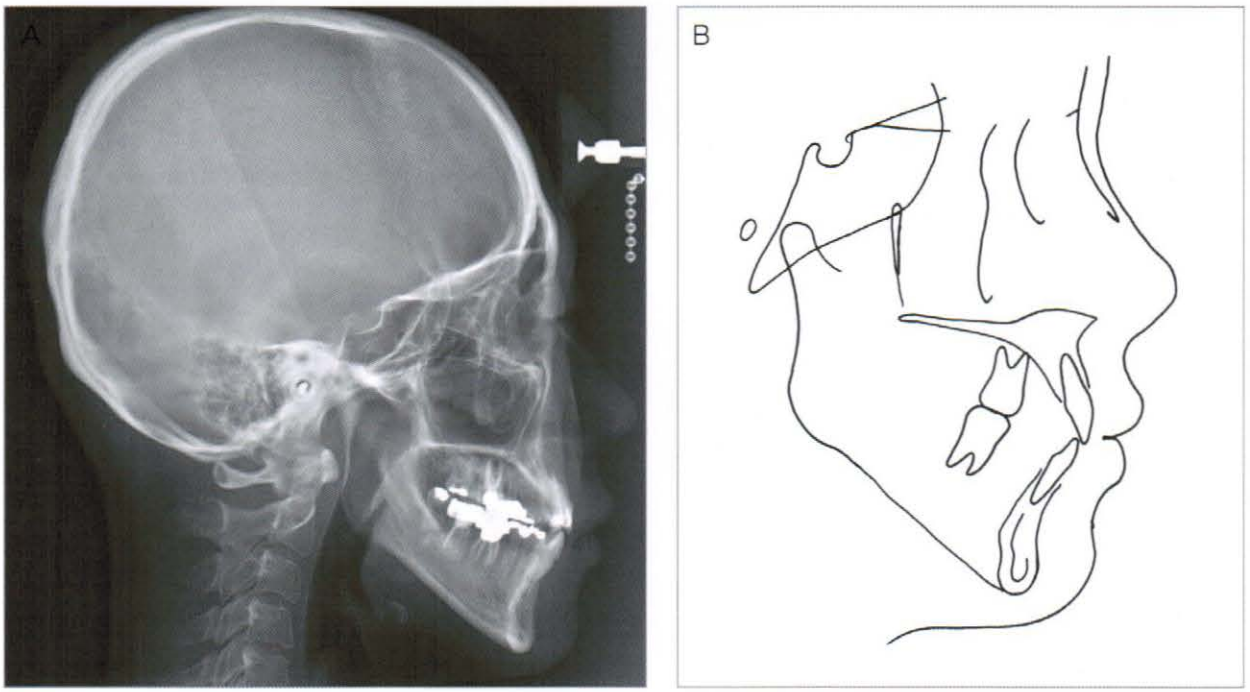
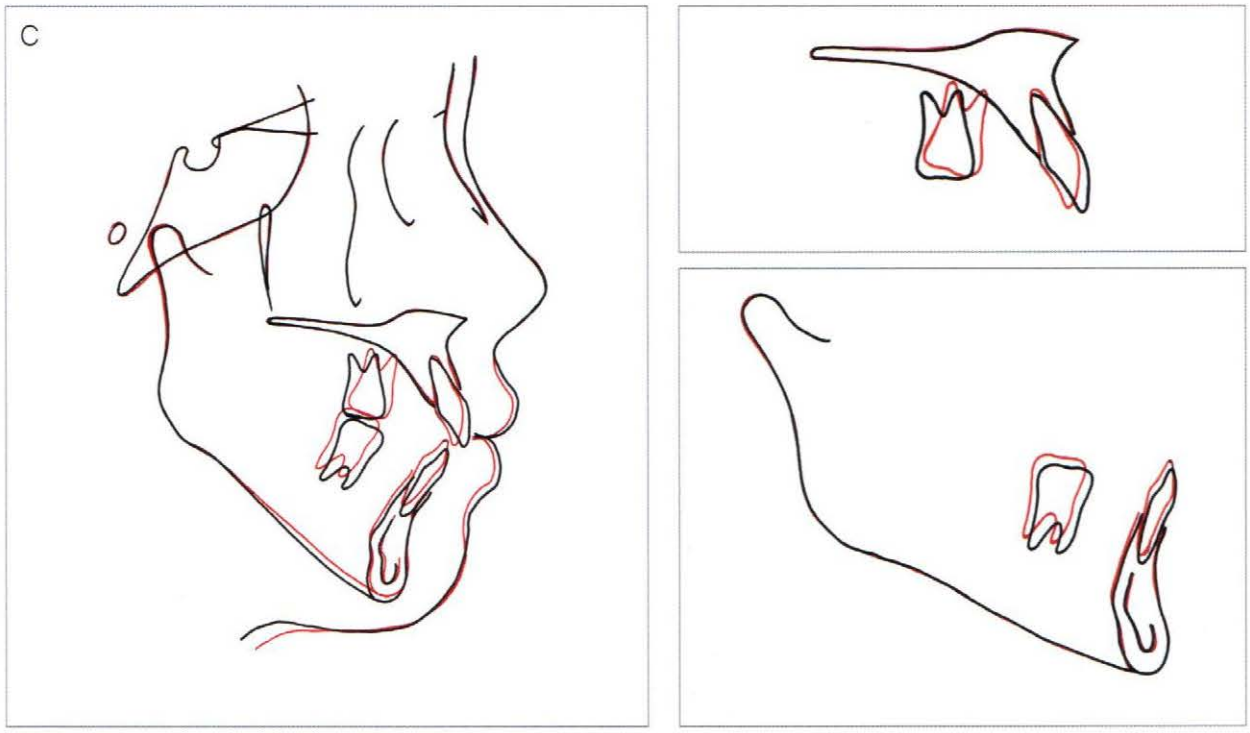


Figure 8-3-17. Intraoral photograph at debonding (2007. 8.14)
Treatment was finished after 26 months.

Figure 8-3-18. Facial photographs at debonding (2007. 8.14)
No great facial changes have occurred. The patient was very happy with the result of orthodontic treatment. She shows a good profile.



C



D

	Norm	SD	T1	T2
SNA	81.6	3.2	79.3	79.3
SNB	79.2	3.0	74.5	74.8
ANB	2.5	1.8	4.8	4.5
FMA	24.3	4.6	41.0	38.8
ODI	72.0	5.5	62.1	64.0
U1 to FH	116.0	5.8	112.4	102.1
IMPA	95.9	6.4	84.2	84.8
IIA	123.8	8.3	122.3	134.2
Esth-U	− 0.9	2.2	3.6	0.7
Esth-L	0.6	2.3	3.5	1.1

Figure 8-3-19. Cephalometric radiograph at debonding (2007. 8.17)
A. Cephalometric radiograph shows a good profile.
B. Cephalometric tracing at debonding.
C, D. Comparison of pre- and post-treatment cephalometric radiograph

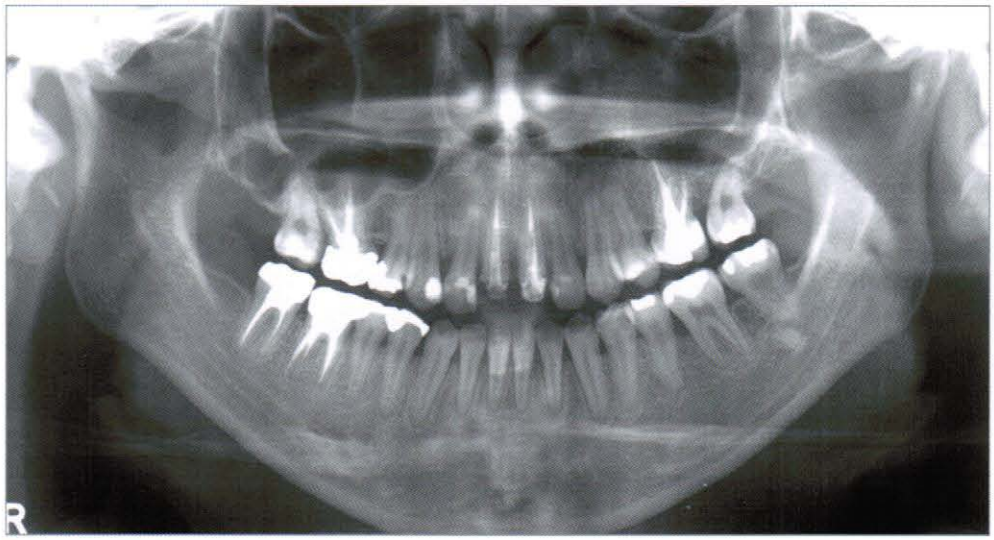


Figure 8-3-20. Panoramic radiograph at debonding (2007. 8.17)
Upper right first and third molars, lower second and third molars have been protracted forward. They show good root parallelism.

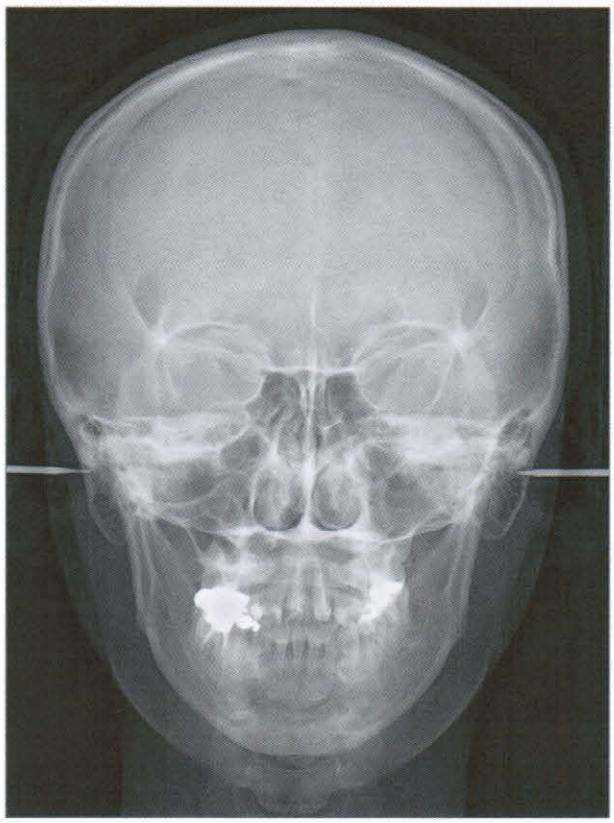


Figure 8-3-21. Postero-anterior radiograph at debonding (2007. 8.17)

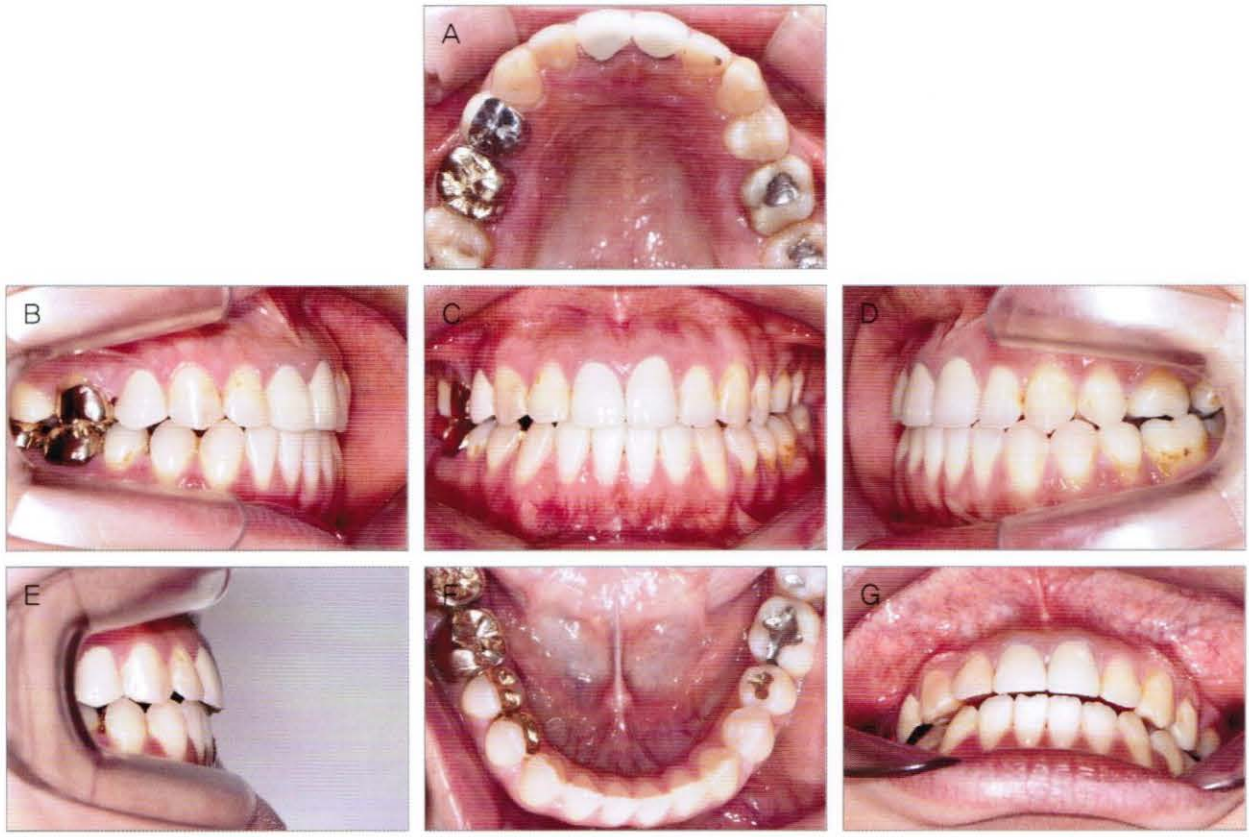


Figure 8-3-22. Intraoral photograph after ceramic crowns of two upper central incisors and right first premolar (2007. 8.31)

■ Case 17 (Figure 8-4-1 to 27)

- Age : 11 years 10 months
- Sex : male
- Chief complaint : impaction of lower right first molar

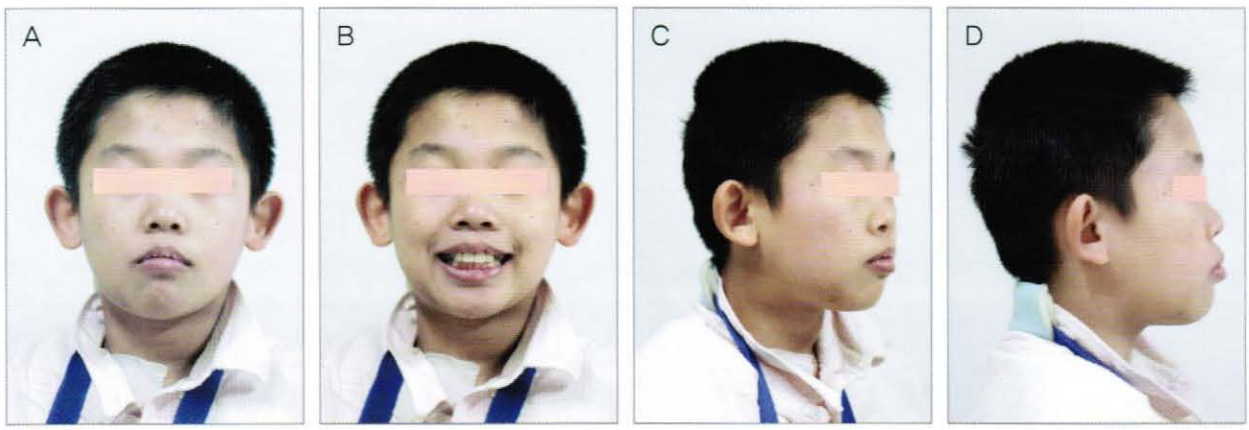


Figure 8-4-1. Pre-treatment facial photograph (2004. 2.17)
The mouth is protruded, with a small nasolabial angle. However the patient had no interest in facial improvements.

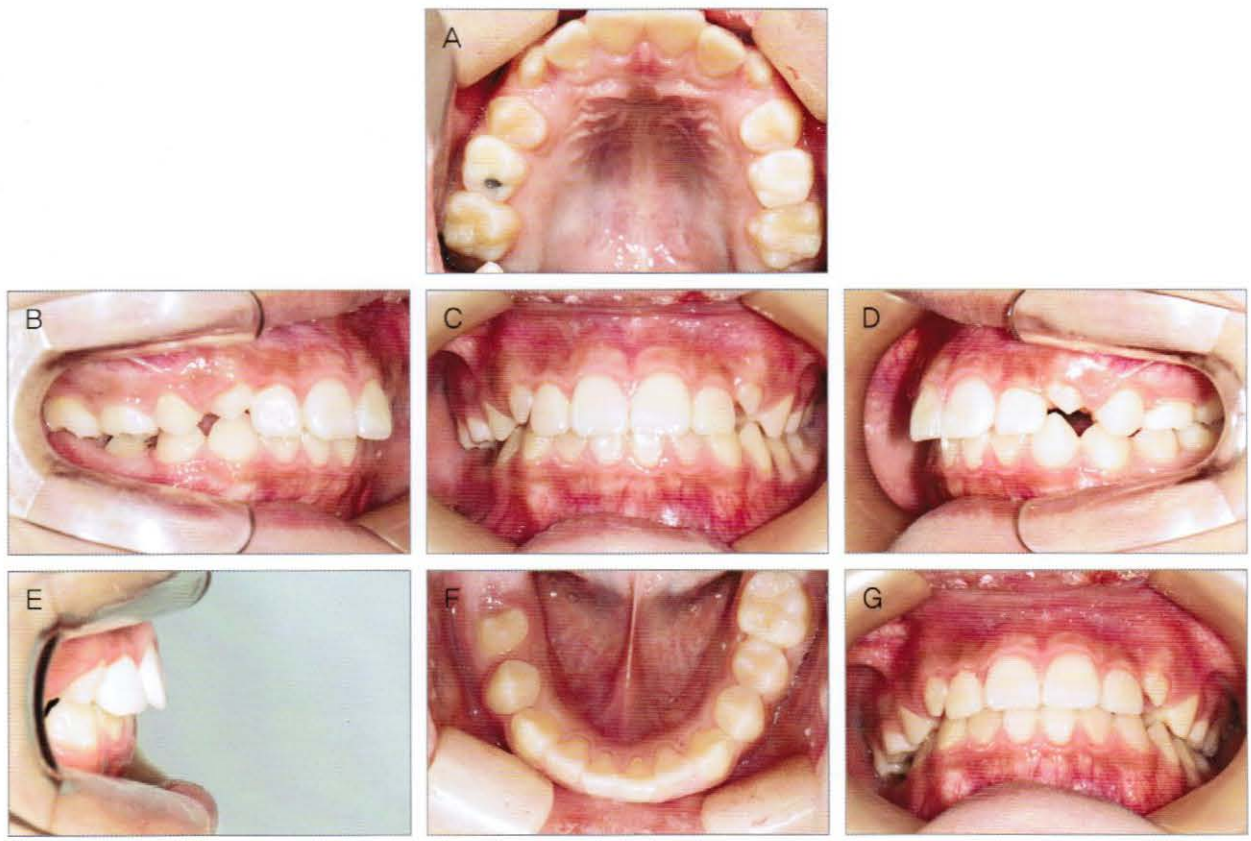
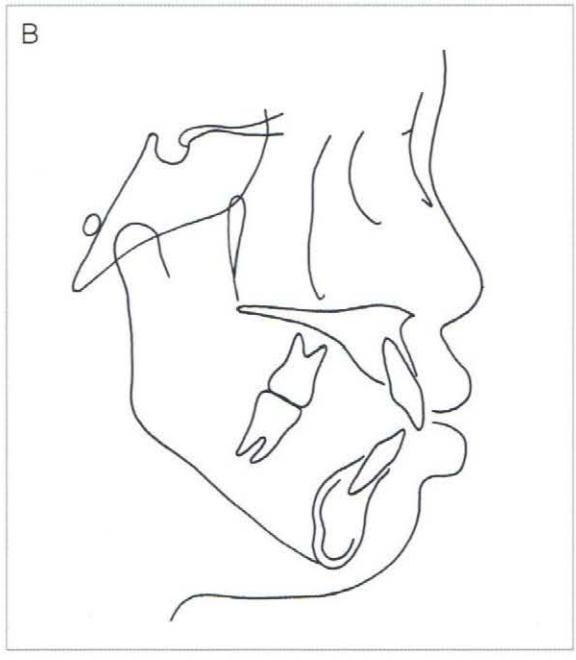


Figure 8-4-2. Pre-treatment intraoral photograph (2004. 2.17)
There is no arch length discrepancy (A, F). Tooth 46 is impacted (B, F). This has caused the upper right first molar to be extruded slightly (C). The right side is in Class II relationship. The lower right premolar has drifted distally causing spacing.



C

	Norm	SD	T1
SNA	82.5	3.2	80.6
SNB	80.4	3.1	78.0
ANB	2.1	1.7	2.6
FMA	22.7	5.3	36.3
ODI	70.2	5.0	63.8
U1 to FH	116.3	5.6	112.9
IMPA	96.6	6.6	93.3
IIA	124.4	8.0	117.5
Esth-U	−0.7	2.2	6.1
Esth-L	0.5	2.3	8.3

Figure 8-4-3. Pre-treatment cephalometric radiograph (A), tracing (B), and measurement (C) (2004. 2.17)
A. Mouth is protruded.
B, C. ANB of 2.6° and APDI of 82.5° are within normal limits.

Figure 8-4-4. Postero-anterior radiograph (2004. 2.17)
There is no facial asymmetry.

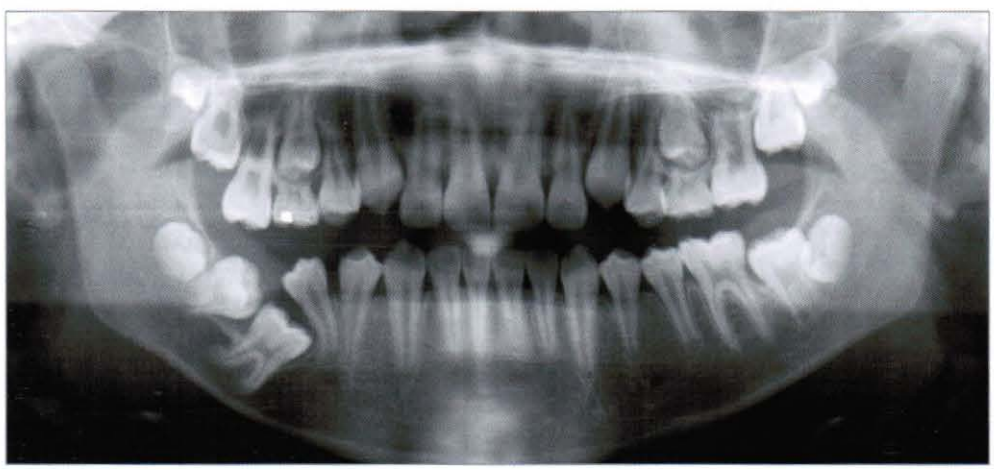


Figure 8-4-5. Pre-treatment panoramic radiograph (2004. 2.17)
The lower right first molar is impacted. This has caused the lower right second premolar to be tilted distally, and the second molar tilted mesially. The upper right first molar is extruded.

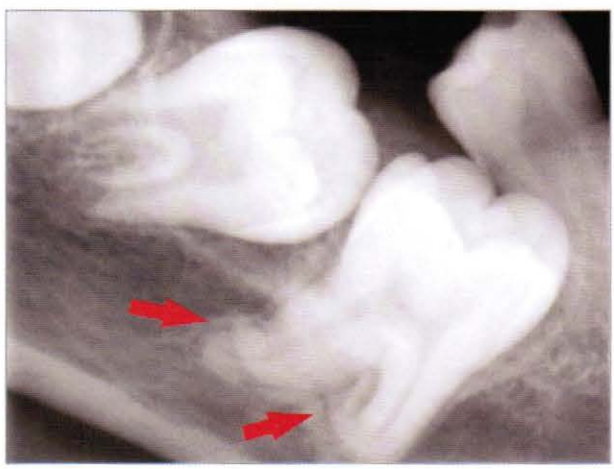


Figure 8-4-6. Lower right first molar impaction pre-treatment (2004. 2.17)
The roots of the first molar are hooked (arrow). In these situations, there is high probability that it will not move even when force is applied. It was decided to extract the tooth.

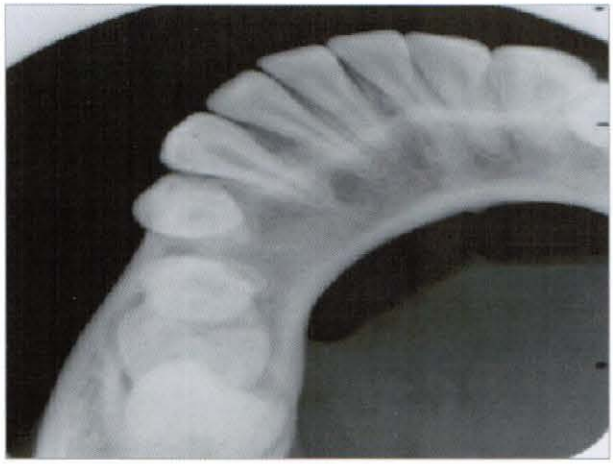


Figure 8-4-7. Occlusal view of the right mandible (2004. 2.17)
The first and second molars are lying in the middle of the mandible bucco-lingually.

Clinical tip ››››

Treatment of impacted lower first molar

When a tooth is impacted, the possible causes must first be investigated. Because the first molar erupts distal to the last deciduous tooth, there is usually no space deficiency. Therefore with impacted first molars, prevention of eruption usually occurs with ankylosis or abnormally formed roots. In these cases, there is no response to forced eruption. One of the following two treatment methods can be used.

1. Extraction of impacted first molar

Extraction can be considered as in many cases there is no movement to traction force. Check whether the third molar is present, and consider closing the extraction space by protraction of the second and third molars. The author recommends this method if the third molar is present.

Advantages:

- It is difficult to bond a button on the impacted first molar through window opening, and also difficult to secure anchorage for traction. A difficult treatment procedure usually has negative effects on the treatment result.
- If a button is bonded on the impacted molar and forced towards the occlusal plane, there is high possibility that it will fail. A second procedure to extract the impacted first molar at a later date can be avoided.

Disadvantages:

- If the third molar is missing or does not erupt, there is a need for prosthodontic treatment.

2. Forced eruption of impacted first molar after window opening

Although button bonding on the impacted molar is difficult, a mini-implant can be inserted mesial to the tooth and used as anchorage during forced eruption. The patient must be informed before the procedure that failure is a possibility. Only after the first molar shows some extrusive movement should the third molar be extracted.

Treatment Progress

- **Window opening of #47 & Surgical Extraction of #46**
  - 2004. 3.2
- **Leveling**
  - 2004. 3.31 U/L : 014″ NiTi
  - 2004. 4.28 U : 018″ NiTi L : 016″ NiTi (#45~#36)
  - 2004. 5.25 U : 017×025″ NiTi
  - 2004. 6.4 L : 018″ ss
  - 2004. 6.30 L : 016×022″ ss
- **Uprighting of #47**
  - 2004. 8.3 U/L : 018×022″ ss with shoe hooks
    + uprighting spring for #47 (018″ ss)
    + Power chain for mesial movement of #45
  - 2005. 1.18 New uprighting spring for #47 (016×022″ ss)
  - 2005. 3.18 Bonding a buccal tube on #47
    L : 014″ NiTi overlay
  - 2005. 4.20 L : 016″ NiTi overlay
  - 2005. 5.11 L : 018″ NiTi overlay
- **Implantation**
  - 2005. 5.25 1.6×6.0 1EA 3⏐2⏐
- **Detailing**
  - 2005. 6.1 L : 016×022″ NiTi
  - 2005. 9.30 L : 018×022″ ss with an L loop for #47 + Class II 1/4″ 6Oz
  - 2006. 3.10~5.17 L : 019×025″ ss with shoe hooks + Modified Herbst appliance on the right side for Class II correction
  - 2006. 5.17 Bracket bonding on #15 & 25
    U : 018″ NiTi
  - 2006. 6.14 U : 016×022″ NiTi
  - 2006. 7.12 U : 018×022″ ss with shoe hooks
- **Debonding**
  - 2006. 12.15

Total 33 months

The chief complaint of the patient in Case 17 was impacted lower right first and second molars. Although the mouth was protruded, the patient and parents did not consider this a problem and did not want any extra extractions except for the impacted lower first molar. First the impacted molar was extracted (refer to Clinical tip), and the crown of the second molar was exposed through window opening. All the teeth except the lower second molar were leveled up to 018x025″ ss wire with shoe hooks, a button bonded onto the buccal surface of the second molar, and 018″ ss uprighting spring inserted as an overlay over the second molar.

Power chain was used for mesial protraction of the distally drifted lower right first and second premolar. As the lower second molar was uprighted, a buccal bracket was bonded, and changed to a continuous wire. During this process, the lower dentition collapsed to the right. The lower midline also leaned to the right. To correct this, a 1.6x6.0mm mini-implant was inserted between the upper right lateral incisor and canine, then steel ligature tightly ligated between the mini-implant head and canine. Class II elastics were given for the right side, but patient compliance was poor. With the consent of the parents, a modified Herbst appliance was used in the right side for around 2 months for correction of the Class II molar relationship and lower midline correction. The mini-implant prevented the side effect of the upper dentition from moving to the right. Although the modified Herbst appliance caused sectional open bite through intrusion of the lower right canine region, interarch elastics during the detailing stage allowed interdigitation. Even after debonding, 018x022" ss wire was left segmentally on the upper first and second molars to prevent extrusion of the upper second molar until eruption of the lower right third molar.

* Sabbagh Universal Spring (SUS), Order Number 607-130-00, Dentaurum, Ispringen, Germany

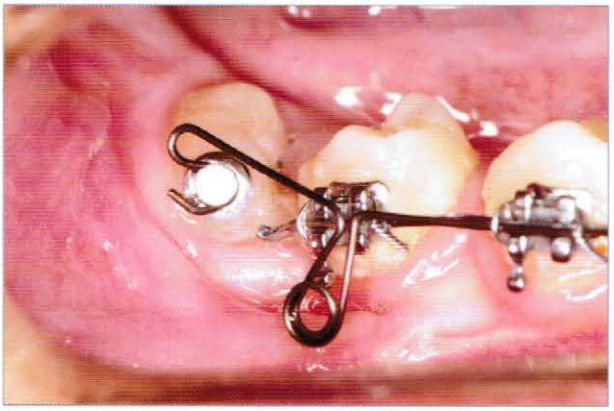


Figure 8-4-8. Uprighting of the second molar after leveling (2004. 8.3)
018×022″ ss wire with shoe hooks is ligated. A button is bonded onto the lower second molar, and 018″ ss wire used as an overlay over the brackets.

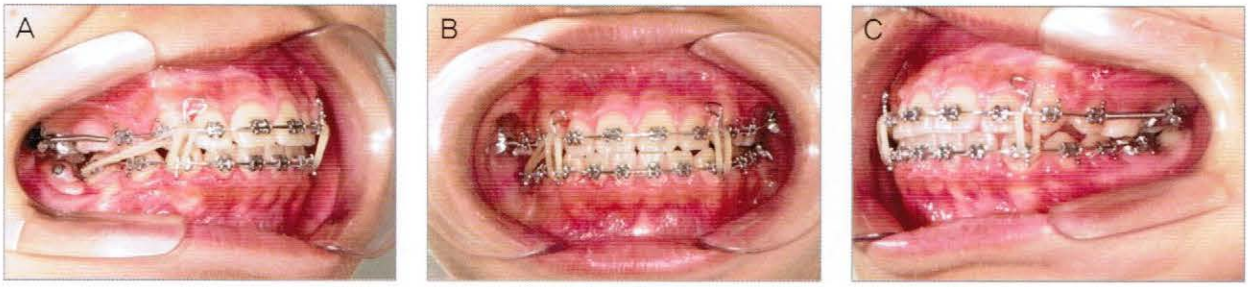


Figure 8-4-9. Lower space closure (2004. 11.10)
Lower right second premolar drifting has caused the second molar to catch on the second premolar to prevent further uprighting. With 018×022″ ss wire with shoe hooks ligated, Class II elastics were used so that the lower right premolar will be moved forward.

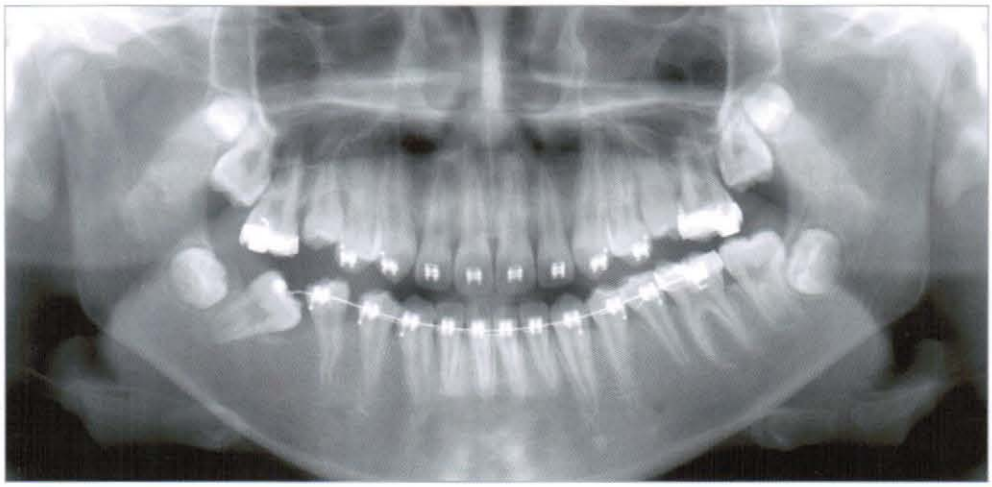


Figure 8-4-10. Uprighting of the lower right second molar checked on panoramic radiograph (2004. 12.10)
The tooth has uprighted a lot compared to pre-treatment (Figure 8-4-5), but much more improvement is required.

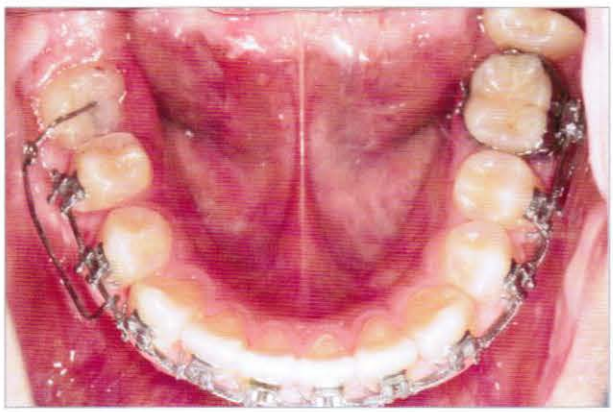


Figure 8-4-11. Different uprighting spring inserted (2005. 1.18)
016×022″ ss was used to construct an uprighting spring. The end of the wire was bent into a tag and bonded onto the second molar. A hook at the mesial end was latched onto the main arch-wire after activation.

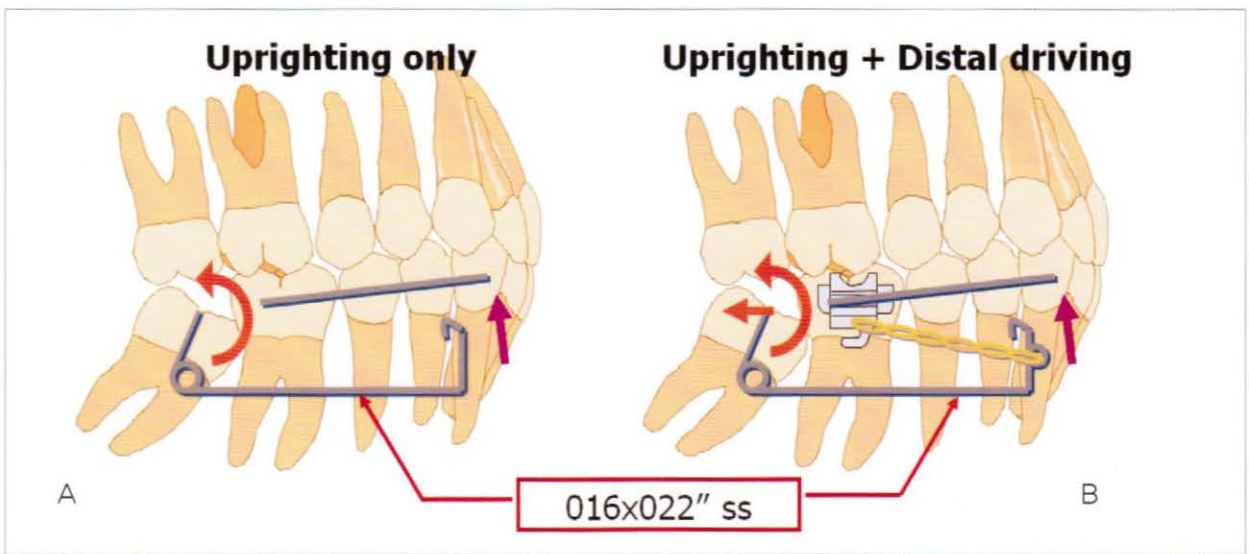


Figure 8-4-12. Comparison of the two uprighting springs
The uprighting spring on the left only exerts distal rotating force on the tooth (A). The uprighting spring on the right (B) has a circle loop on the mesial leg, and placing power chain from this loop to the hook of the first molar will cause force to be applied distally. This is effective when the impacted tooth is catching beneath the crown of the mesial tooth. In Case 17, distal rotation force was placed through the left uprighting spring (A), and it showed good results.

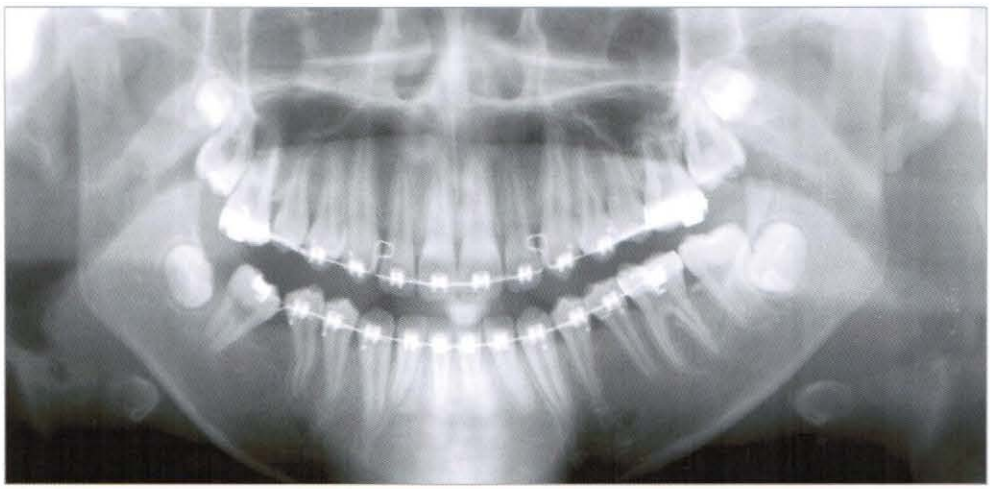


Figure 8-4-13. Uprighting of the lower right second molar checked on panoramic radiograph (2005.4.20)
The impacted lower second molar has been uprighted a fair amount. However further adjustments are required to obtain root parallelism. During this process, the teeth on the right side will be pulled forward. The lower midline will shift to the right and the Class II relationship will become worse.

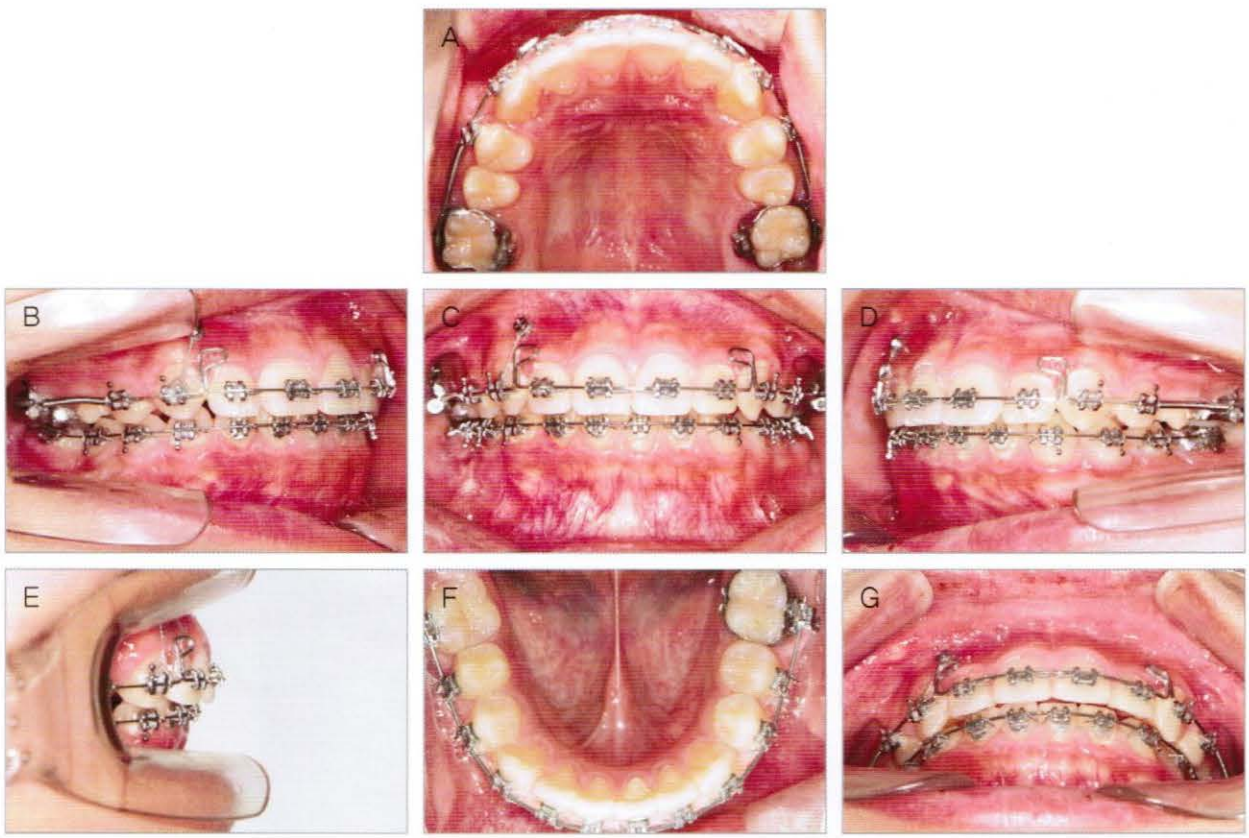


Figure 8-4-14. Mini-implant insertion (2005. 5.25) and uprighting of the lower right second molar for 10 months (2005. 6.1)
Uprighting has progressed considerably (F), but the bite has deepened as a side-effect (B), and the lower midline has shifted to the right (C). The right side is in Class II relationship (B). To prevent worsening of the side effects, a 1.6×6.0mm mini-implant is inserted between the upper right lateral incisor and canine, and tight steel ligature placed between the mini-implant head and the canine bracket (C). After reinforcing anchorage in the upper dentition, Class II elastics are worn after changing the lower wire to 018×022″ ss (2005. 9.30, Figure 8-4-15).

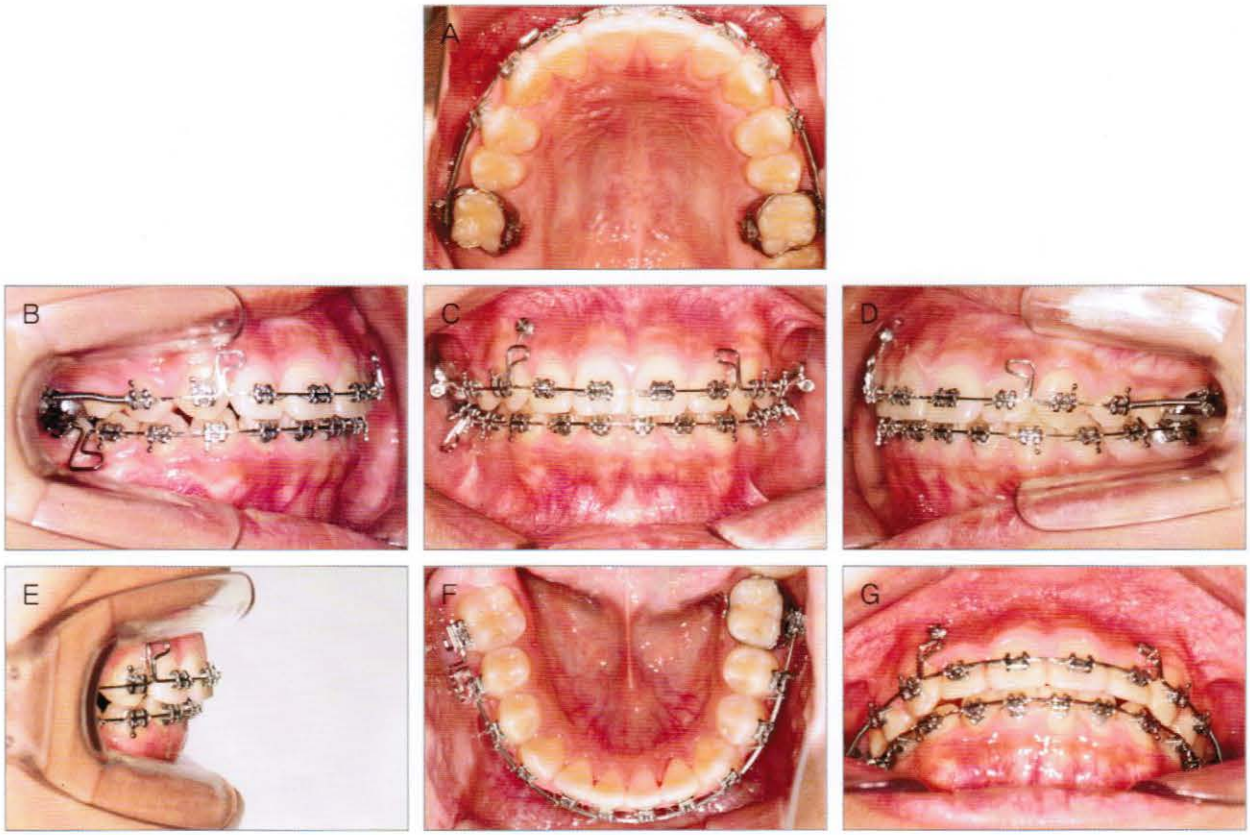


Figure 8-4-15. Uprighting of lower right second molar complete after 14 months (2005. 9.30)
Uprighting of the lower right second molar was complete after 14 months (C). 018×022″ ss is also used in the lower arch, with an L-loop inserted mesially for control of the lower right second molar (B). Class II elastics were worn on the right side to improve the Class II relationship. The lower midline is shifted to the right (C).

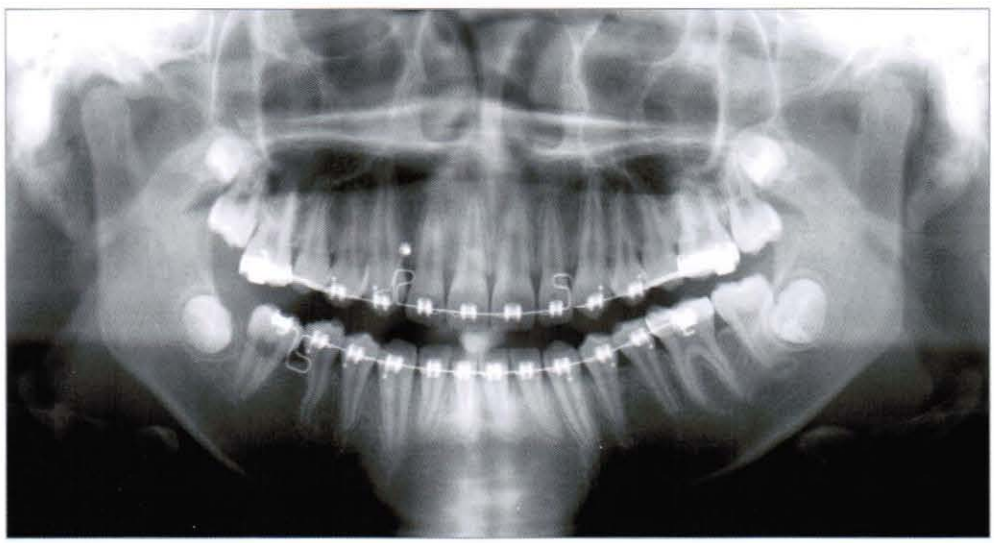


Figure 8-4-16. Uprighting of lower right second molar complete after 14 months (2005. 9.30)
Uprighting of the lower right second molar was complete after 14 months. To increase anchorage on the upper arch during Class II elastic wear, a 1.6×6.0mm mini-implant has been inserted between the upper right lateral incisor and canine. 018×022″ ss is used in the lower arch, with an L-loop inserted mesially for control of the lower right second molar. The lower midline is shifted to the right.

Figure 8-4-17. Detailing stage. Photograph taken with Modified Herbst appliance inserted on the right side (2006. 3.10)
The Class II relationship of the right side was to be corrected with elastics, but because no effects were observed, a Modified Herbst appliance was inserted. The Modified Herbst appliance is used with 019×025" ss wire with shoe hooks in the lower arch. The upper wire has cinch-backs.
H. Modified Herbst appliance inserted in the denitiform model.

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*Sabbagh Universal Spring (SUS), Order Number 607-130-00, Dentaurum, Ispringen, Germany

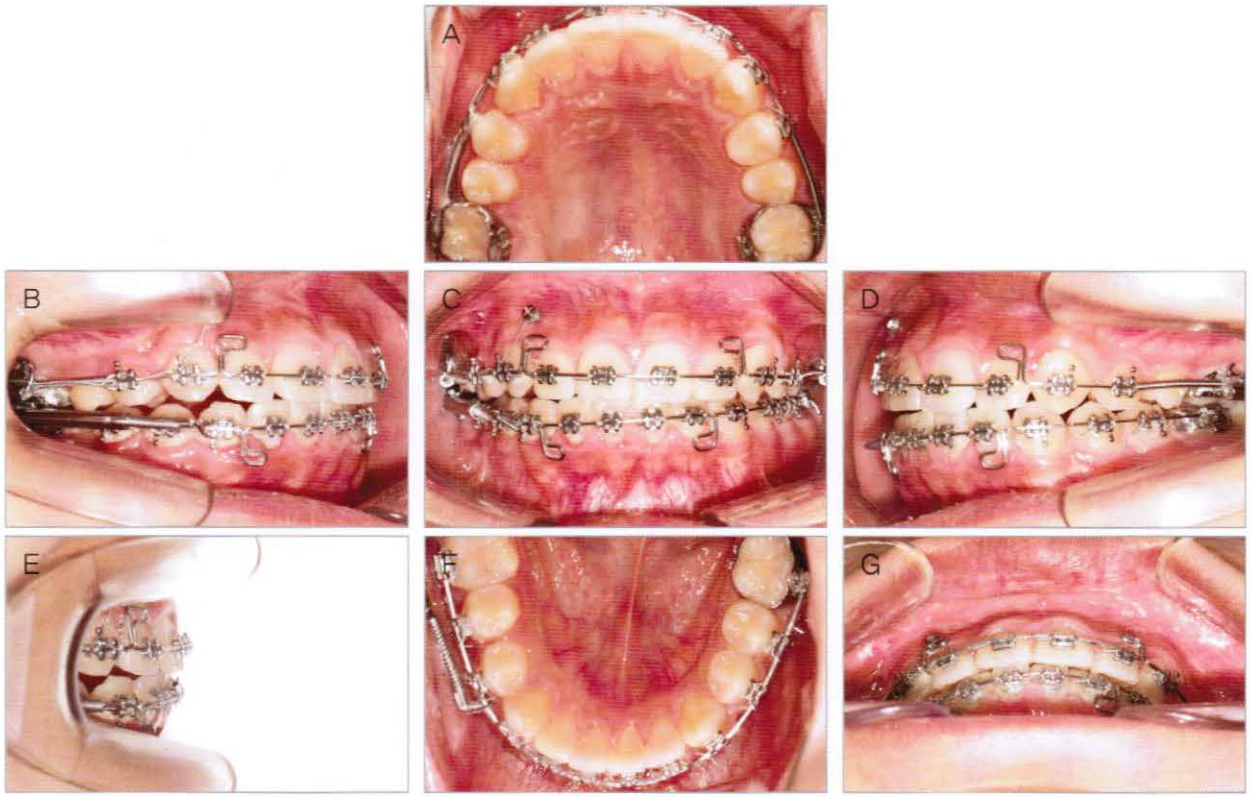


Figure 8-4-18. 2 months after use of Modified Herbst appliance (2006. 5.17)
The Class II relationship has been corrected to Class I (B). There is partial open bite (B). The upper and lower midlines are coincident (C). Although the lower arch has cinch-backs, slight spacing has occurred distal to the first premolar (F). The upper second molars were bonded on this day and 018" NiTi ligated.

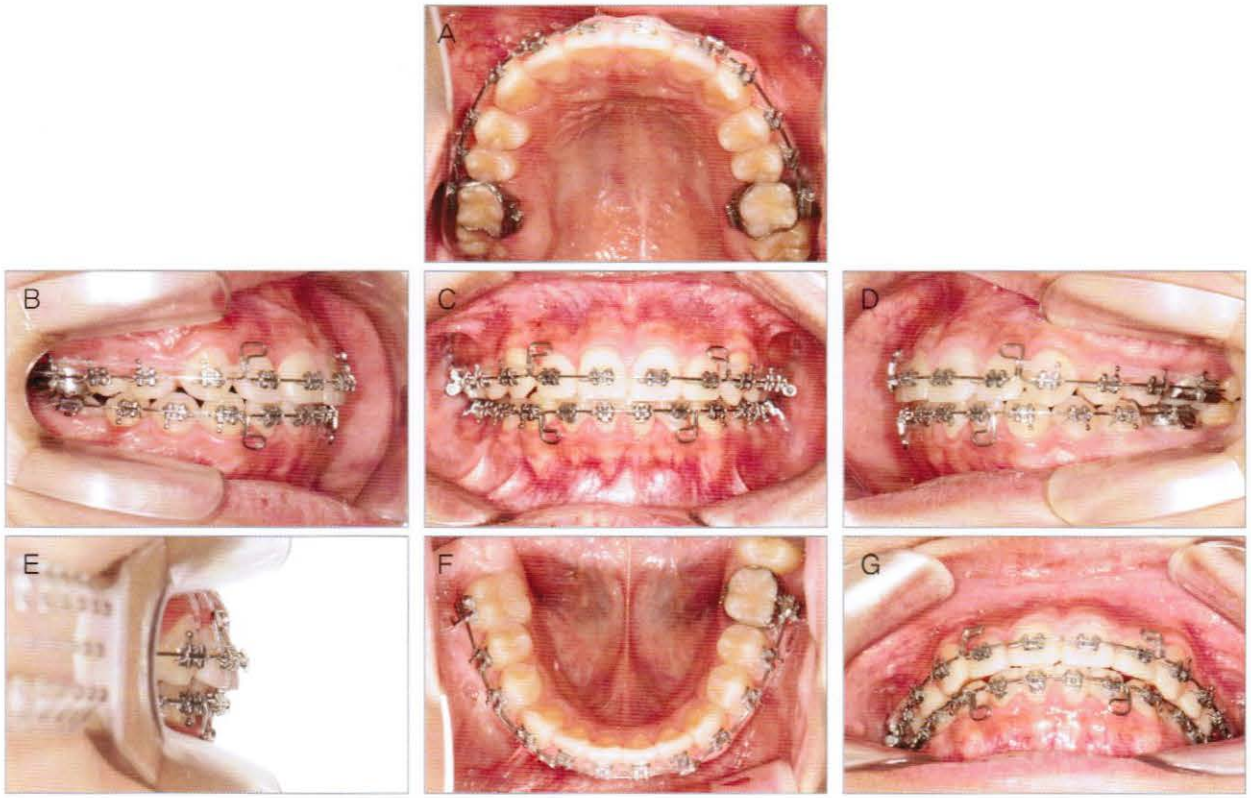


Figure 8-4-19. Detailing stage (2006. 7.12)
The midlines are coincident, and Class I relationship has been obtained. The upper right second molar is in the process of erupting.

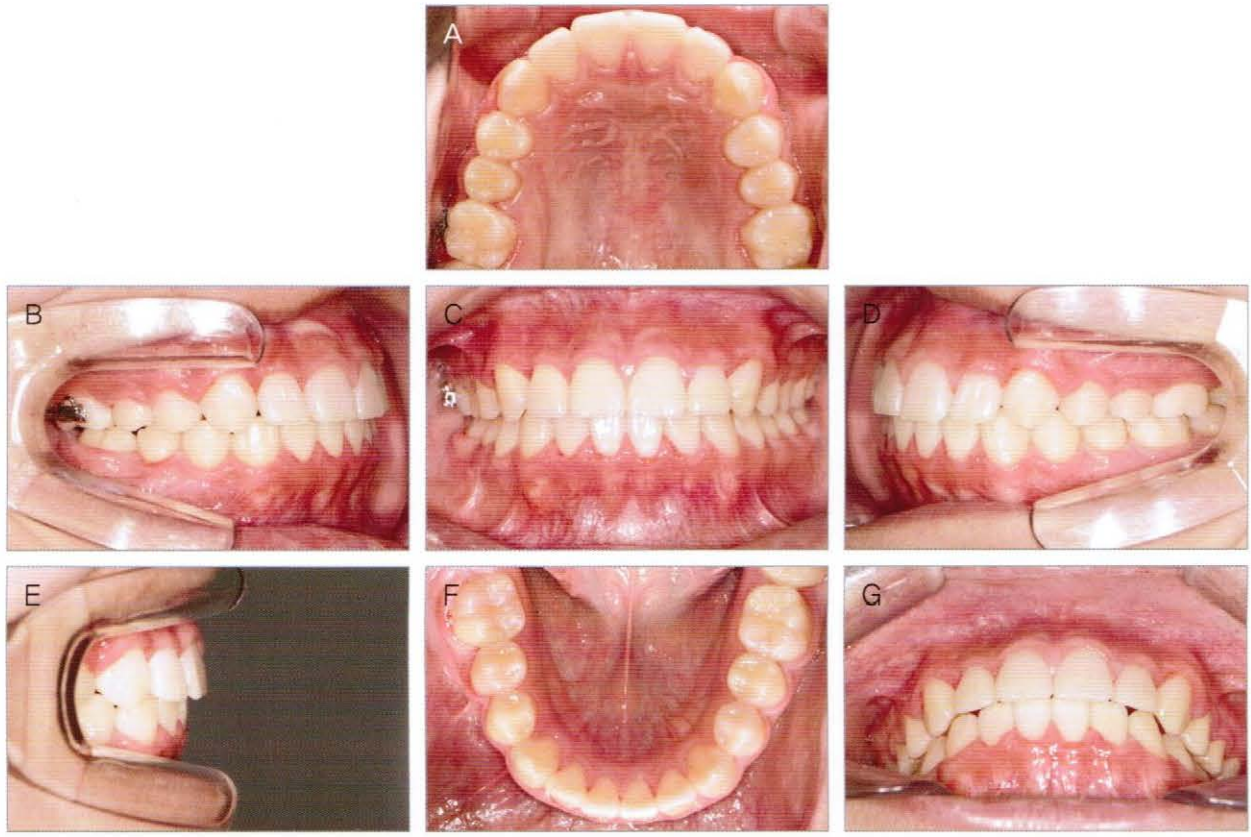


Figure 8-4-20. Intraoral photograph at debonding (2006. 12.15)
The midlines are coincident, and Class I relationship has been obtained. Both upper second molars have erupted, but the lower right third molar has not erupted yet. Wire has been left on the upper right first and second molars to prevent overeruption of the upper right second molar (B).

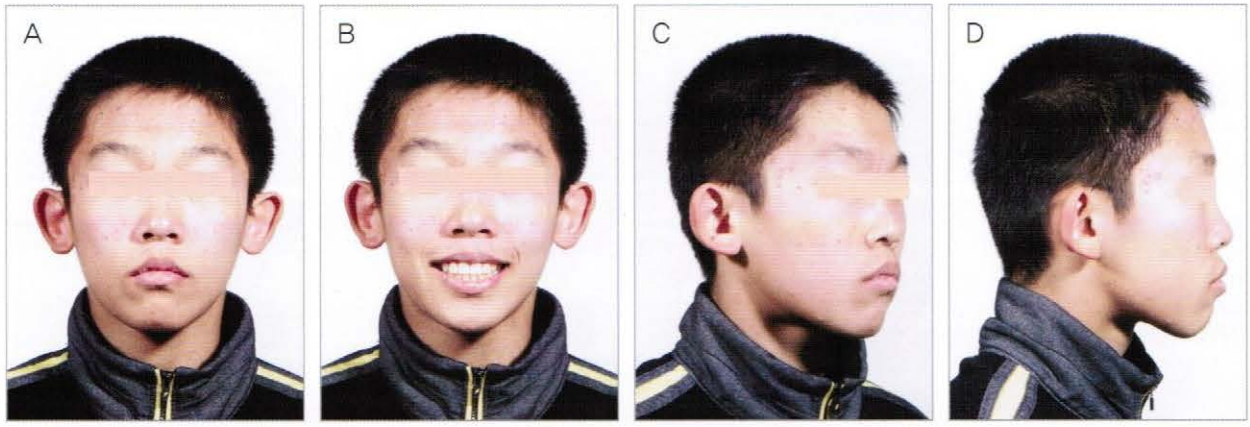
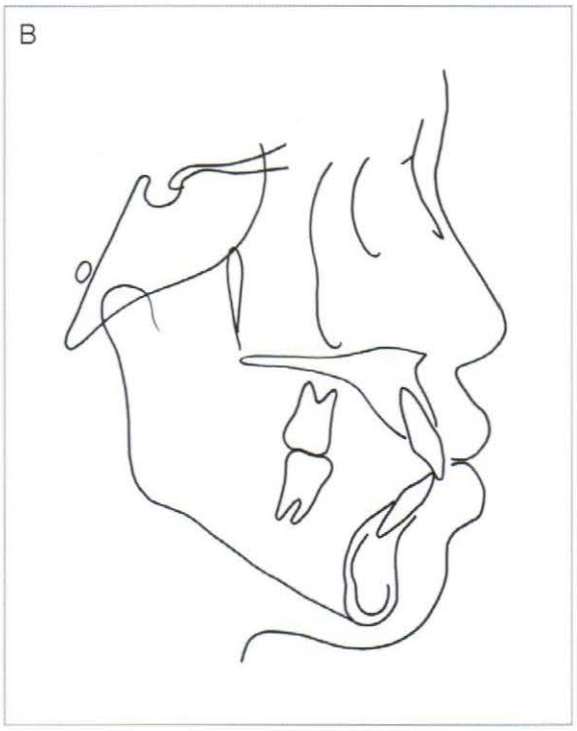
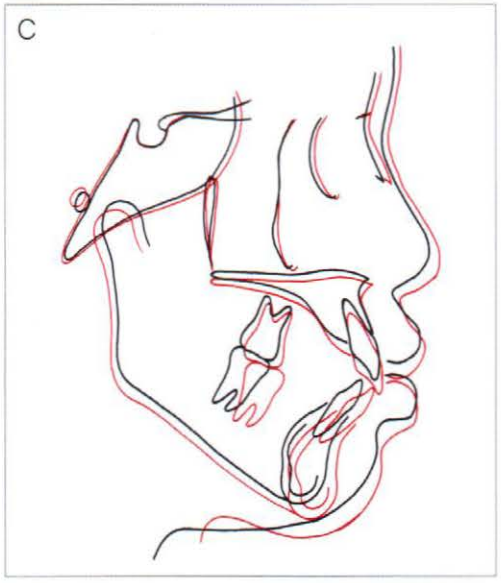


Figure 8-4-21. Facial photograph at debonding (2006. 12.15)
No significant change of the face has occurred. The patient was very pleased with orthodontic treatment.





D

	Norm	SD	T1	T2
SNA	82.5	3.2	80.6	81.3
SNB	80.4	3.1	78.0	79.7
ANB	2.1	1.7	2.6	1.6
FMA	22.7	5.3	36.3	33.7
ODI	70.2	5.0	63.8	63.5
U1 to FH	116.3	5.6	112.9	112.1
IMPA	96.6	6.6	93.3	97.2
IIA	124.4	8.0	117.5	117.1
Esth-U	-0.7	2.2	6.1	3.3
Esth-L	0.5	2.3	8.3	3.2

Figure 8-4-22. Cephalometric radiograph and measurement at debonding (2006. 12.15)
A. Mouth protrusion can be seen on cephalometric radiograph.
B. Cephalometric tracing at debonding.
C, D. Cephalometric superimposition of pre- and post-treatment.

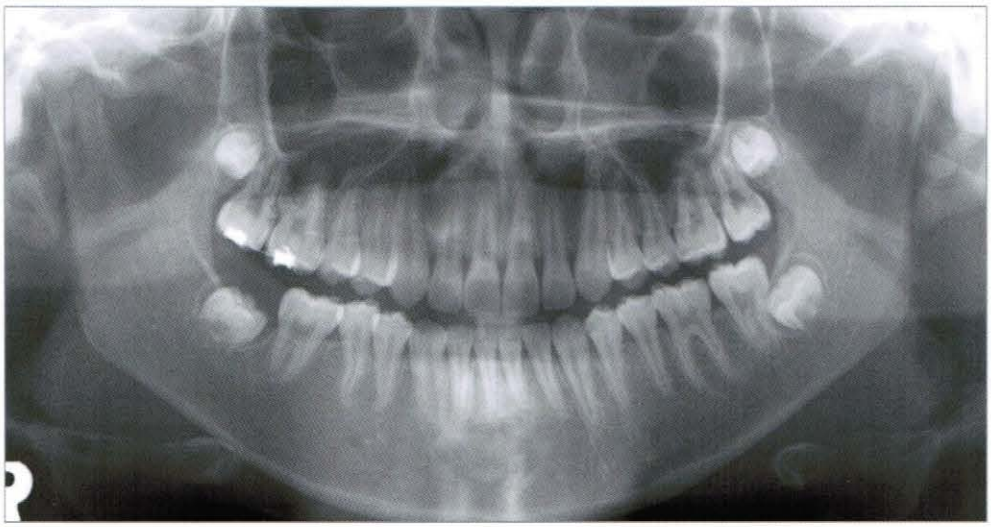


Figure 8-4-23. Panoramic radiograph at debonding (2006. 12.15)
The lower right second molar and second premolar show good root parallelism. Segmental wire has been left on the upper right first and second molar until eruption of the lower right third molar.

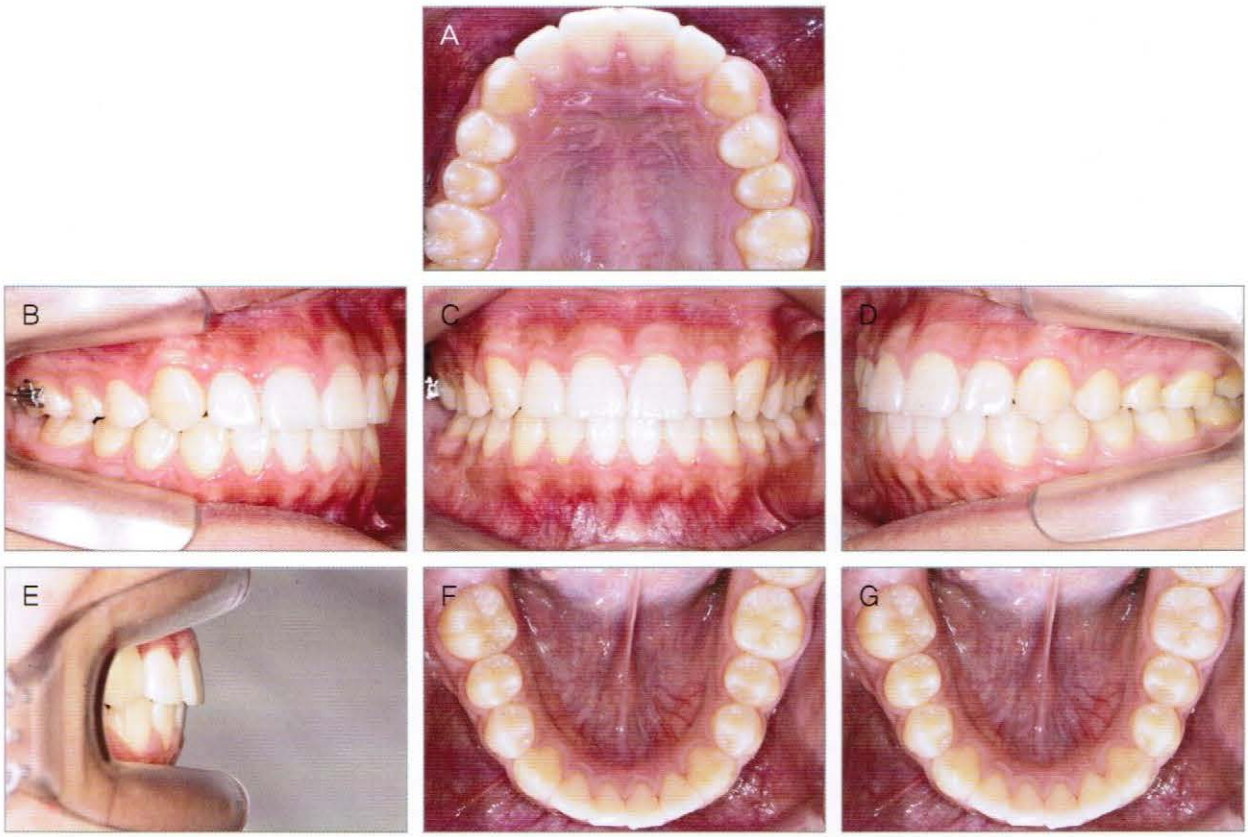


Figure 8-4-24. One year post-retention (2008. 2.1)
Occlusion is well maintained.

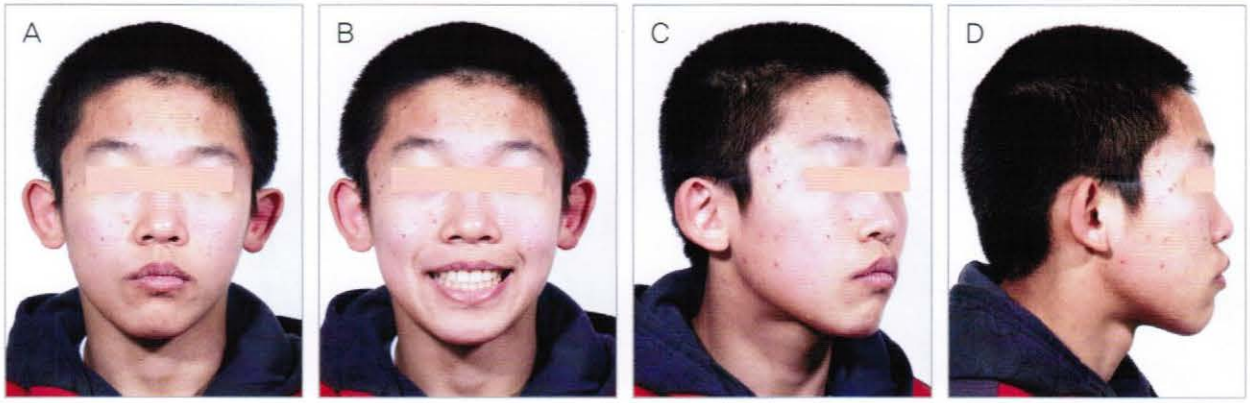


Figure 8-4-25. One year post-retention (2008. 2.1)
A lot of skeletal growth has occurred, but there is little change in the face.

Figure 8-4-26. One year post-retention (2008. 2.1)

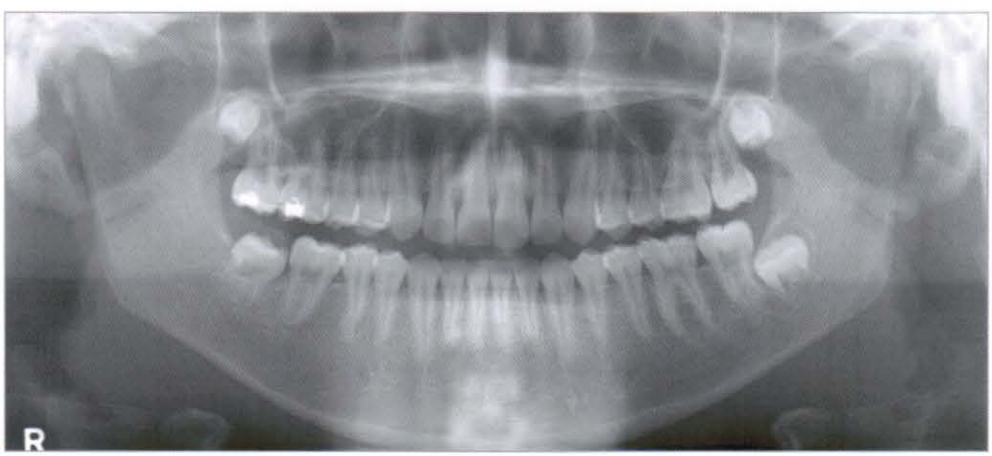


Figure 8-4-27. One year post-retention (2008. 2.1)
The lower right third molar is erupting (compare with Figure 8-4-23).

Ⅳ. Intrusion of upper molar

There are many methods of intruding an extruded upper molar. In section Ⅳ), 2 molar intrusion cases will be introduced, and in section Ⅴ), a case with lower molar intrusion and uprighting will be explained. Section Ⅵ) summarizes a few other methods.

■ Case 18 (Figure 8-5-1 to 10)

- Age : 18 years 0 months
- Sex : male
- Chief complaint : extrusion of upper left second molar

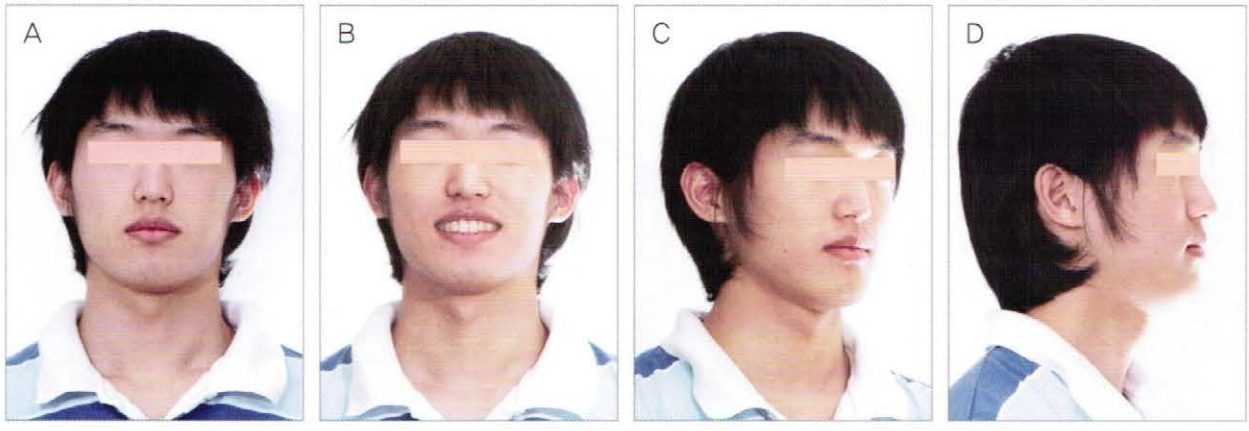


Figure 8-5-1. Pre-treatment facial photograph of Case 18 (2006. 1.3)
He shows good facial profile.

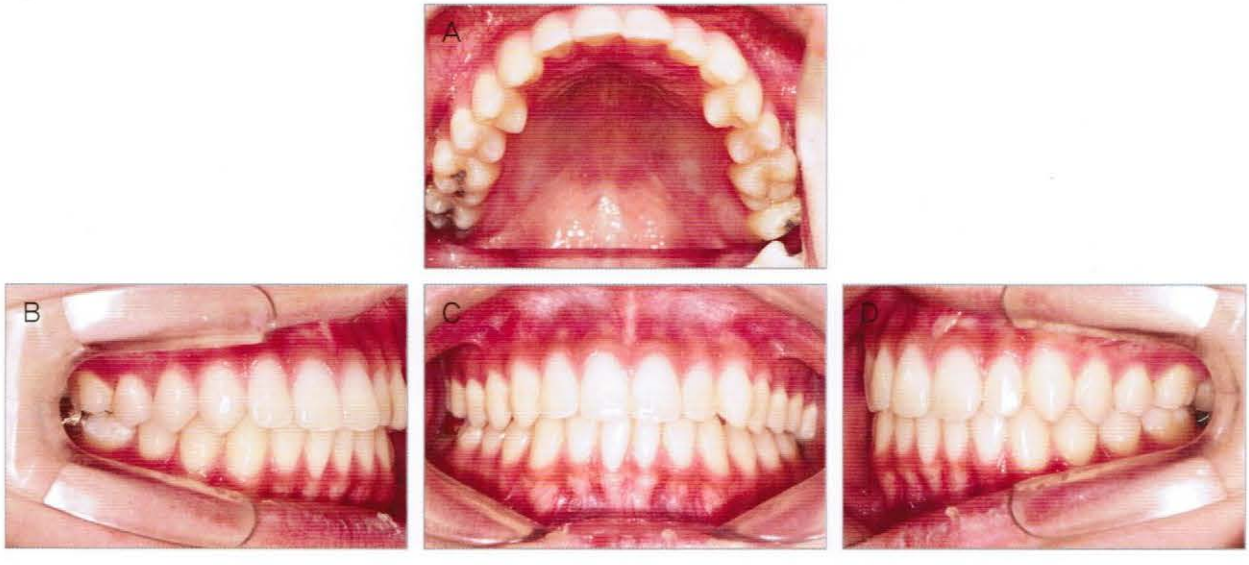


Figure 8-5-2. Pre-treatment intraoral photograph of Case 18 (2006. 1.3)
The upper left second molar is overerupted (A). The tip of the lower left third molar can be seen (F). He shows a normal occlusion except for the missing lower left second molar.

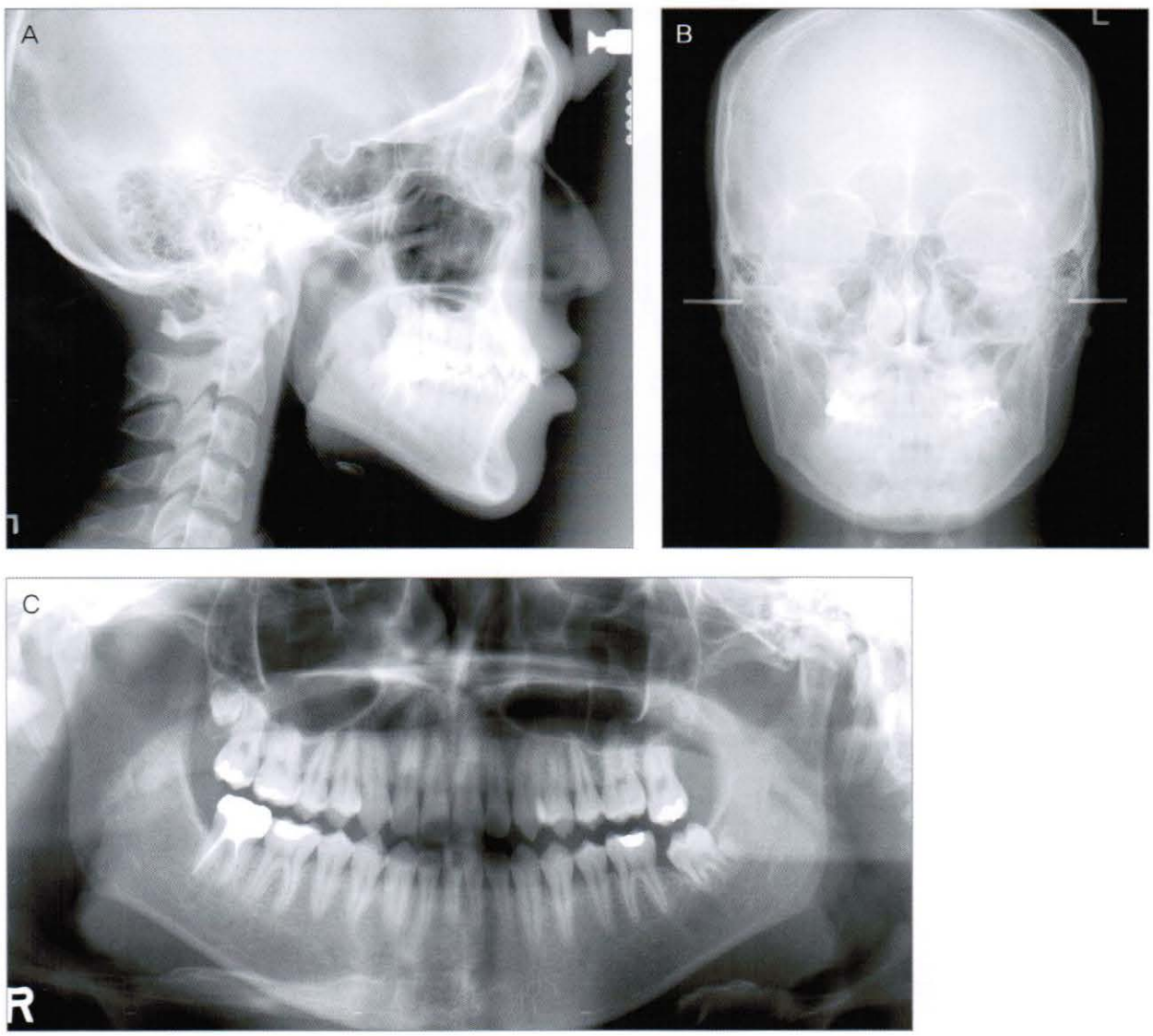


Figure 8-5-3. Pre-treatment cephalometric radiograph (A), postero-anterior radiograph (B), and panoramic radiograph (C) (2006. 1.3)
A. The patient has a good profile with normal dental and skeletal relationship.
B. There is good left and right symmetry.
C. The upper left second molar shows overeruption. The lower left third molar is prevented from further eruption due to contact with the overerupted upper second molar. There is around 4~5mm of space mesially.

Past Dental History

A dentist at a private clinic referred to the Oral surgeon the extraction of the lower left third molar. The treatment plan was to extrude the impacted second molar after extraction of the third molar (Figure 8-5-4A, 2005.1.5). However, the second molar was extracted instead of the third molar by mistake (Figure 8-5-4B, 2005.3.4). 5 months past, and the upper left second molar overerupted further, and the lower third molar drifted forward (Figure 8-5-4C, 2005.8.6). The oral surgeon also extracted the upper left third molar and referred the patient to our department.

Clinical tip ››››

Vertically impacted second molar (Figure 8-5-4A)

Even if a button is bonded after window opening, forced eruption is difficult. Also there is risk of ankylosis. Therefore in such a case shown in Figure 8-5-4A, it may be a good option to extract the upper and lower second molars.

If it is imperative that the lower second molar be forcefully erupted, the upper second molar must first be intruded before attempting forced eruption of the lower second molar. It will be safer to extract the third molar when tooth movement of the second molar is confirmed.

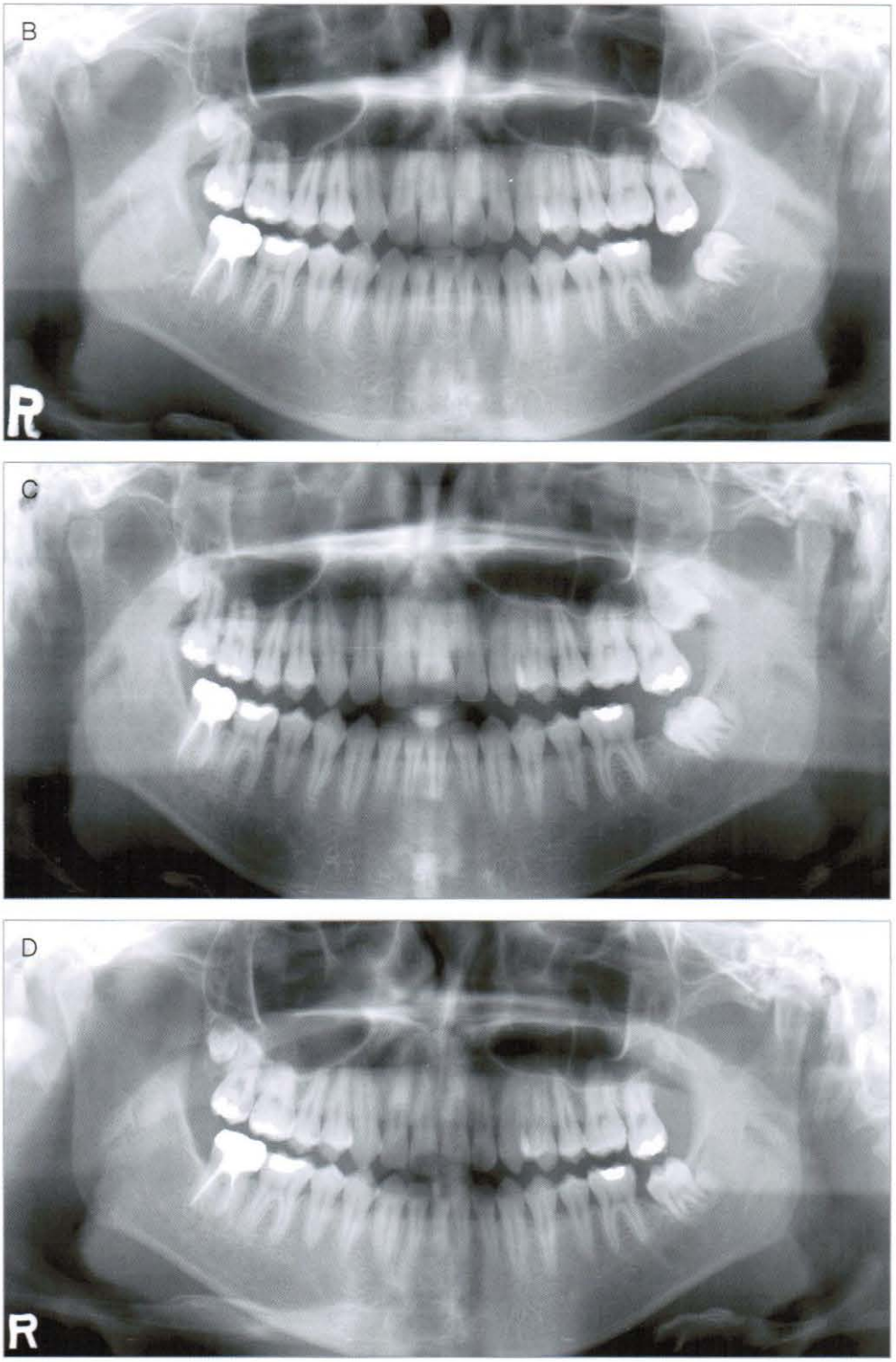


Figure 8-5-4. Panoramic radiograph which shows the patient's dental history

A. Radiograph taken before referral of the lower left third molar to the oral surgeon with a plan for forced eruption of the second molar (2005. 1.5)

B. The lower left second molar and lower right third molar have been extracted (2005. 3.4)

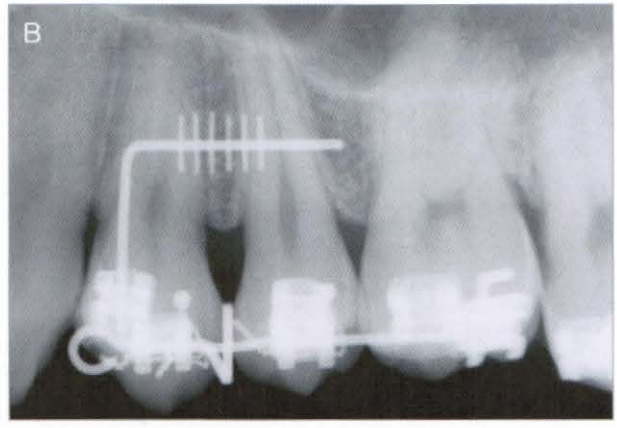
C. Radiograph at the time the oral surgeon came for consultation at our department (2005. 8.6). The lower left third molar has drifted forward to make the second molar extraction space smaller. From this radiograph, it was recommended that the upper left second molar be extracted, but when the patient first visited our department, the third molar had already been extracted. If the second molar had been extracted, the third molar would have erupted well into the second molar space.

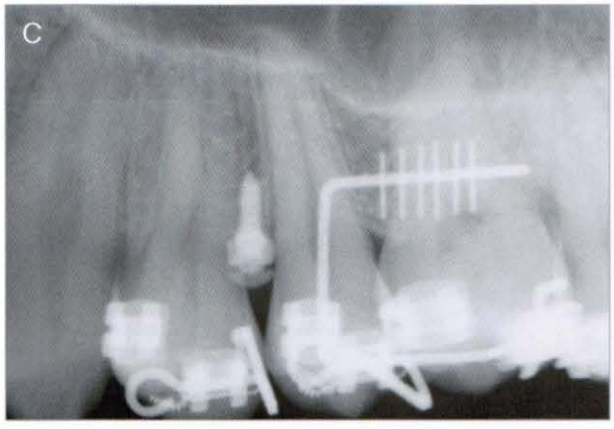
D. Panoramic radiograph taken as part of the diagnostic exam at our department (2006. 1.3). The lower left third molar has drifted further mesially.

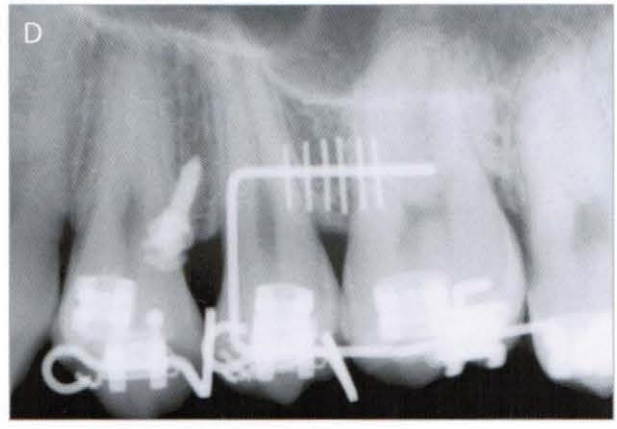
Treatment Progress

- **Implantation**
  - 2006. 1.25 Buccal 1.6×6.0 2EA |4↓5↓6
  - 2006. 2.3 Palatal 1.6×8.0 2EA |5↓6↓7
- **Intrusion of upper molars** 10 months
  - 2006. 2.28 Bonding of buccal and palatal bars (0.9mm) with hooks + power chains
- **Debonding**
  - 2006. 12.13 Debonding

Intrusion was attempted for a total of 10 months. Detailed descriptions will be given with each photograph.







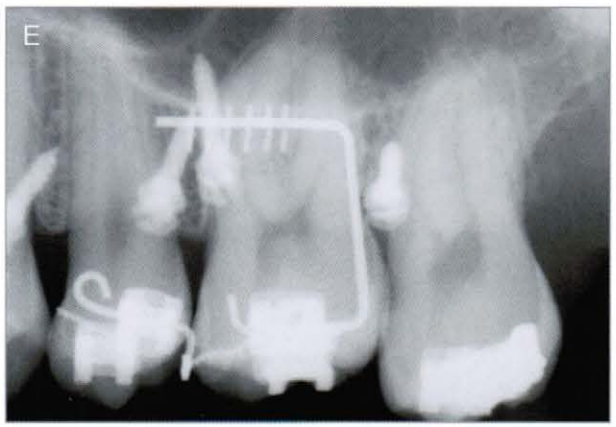


Figure 8-5-5. Mini-implant insertion
The first thing to consider is the position of insertion. On periapical radiograph the interradicular distance between the upper first and second molars is narrow (A). Kim's stent was used to implant 1.6×6.0mm mini-implants bucally between the first and second premolars (C, D), and between the second premolar and first molar. In the palate, 1.6×6.0mm mini-implants were inserted between the second premolar and first molar, and between the first and second molars (E). The left two are the buccal mini-implants and the two on the right are the palatal mini-implants. The position of the mini-implant tip shows that they have been well implanted between roots.

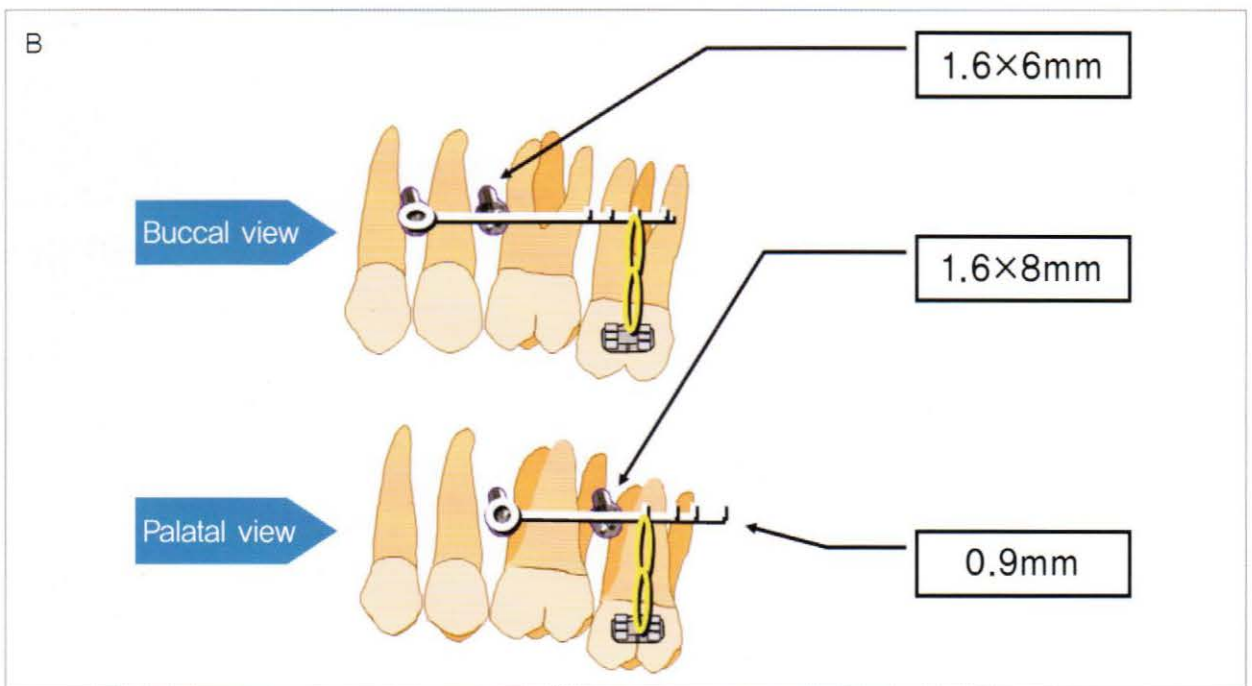
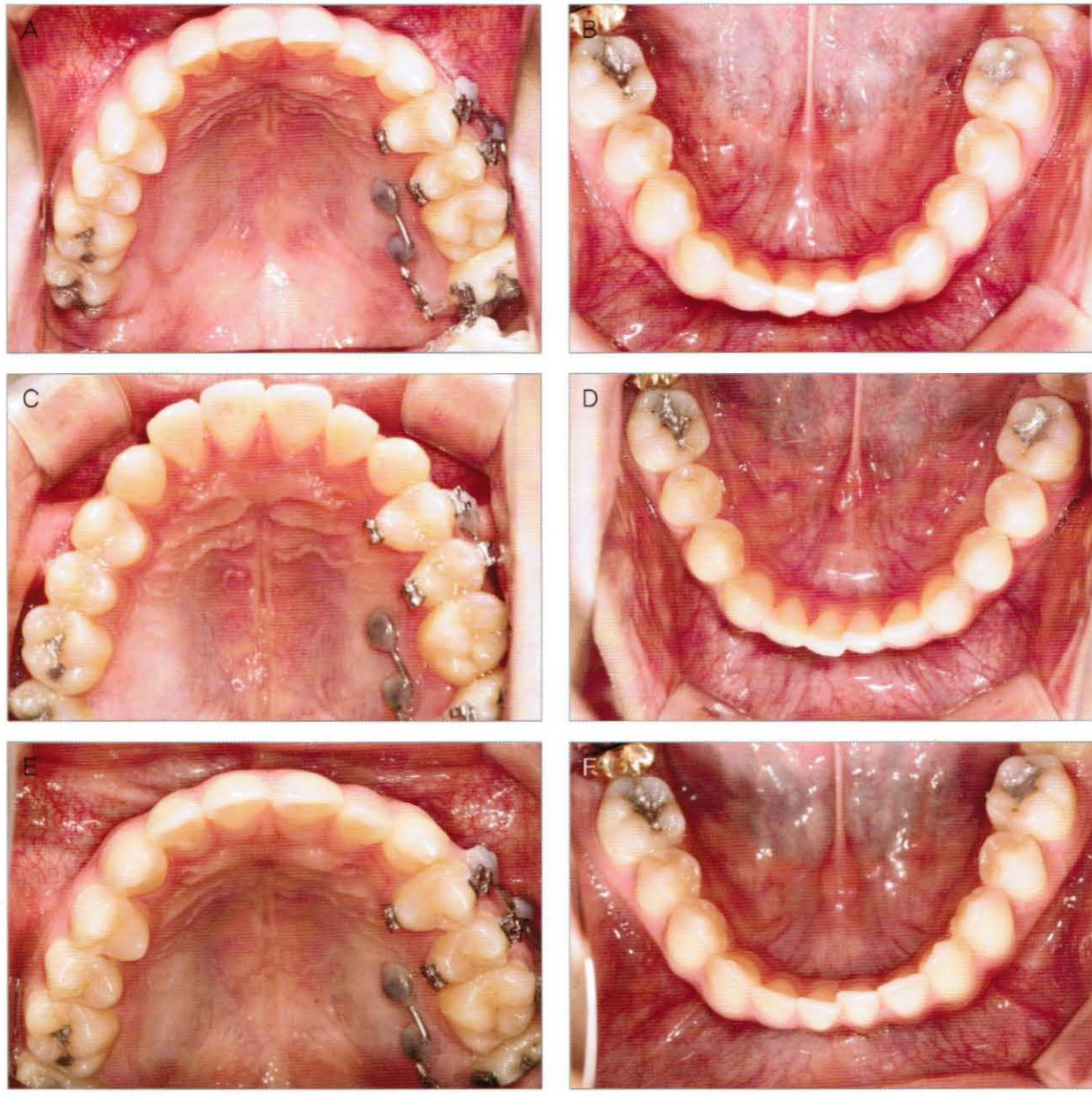


Figure 8-5-6. Intrusion mechanism of the extruded second molar
Many hooks placed on the 0.9mm wire will help with force adjustment.

Figure 8-5-7. Mechanics of extruded second molar (2006, 2,28)
Brackets were bonded on the left premolars and first molar, but there was no need to use them during treatment.



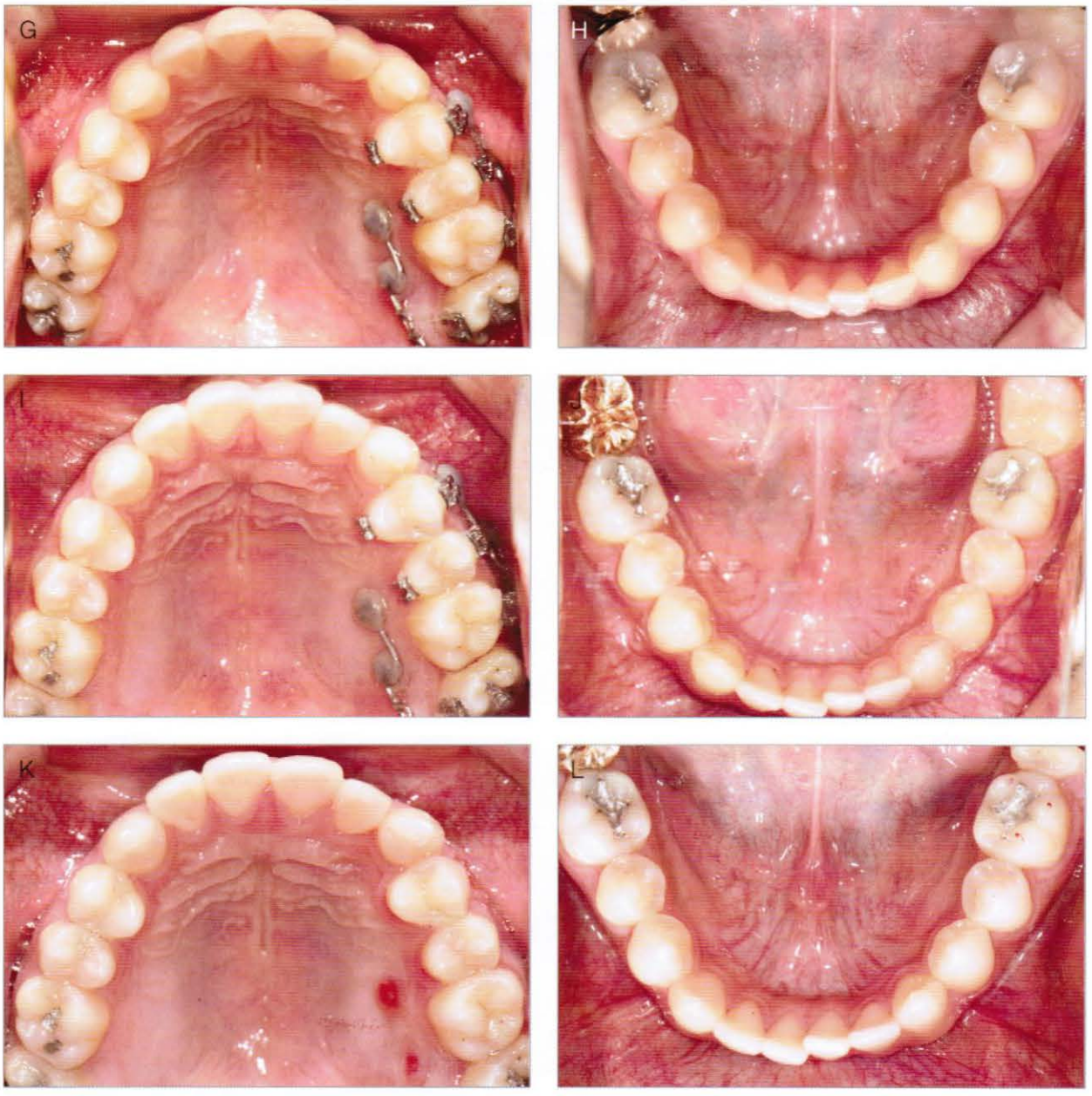


Figure 8-5-8. Treatment progress
A, B. Beginning of intrusion (2006. 2.28)
C, D. After 3 months (2006. 5.17)
E, F. After 5 months (2006. 7.11)
G, H. After 6 months (2006. 8.9)
I, J. After 7 months (2006. 9.6)
K, L. After 10 months (2006. 12.13), debonded.

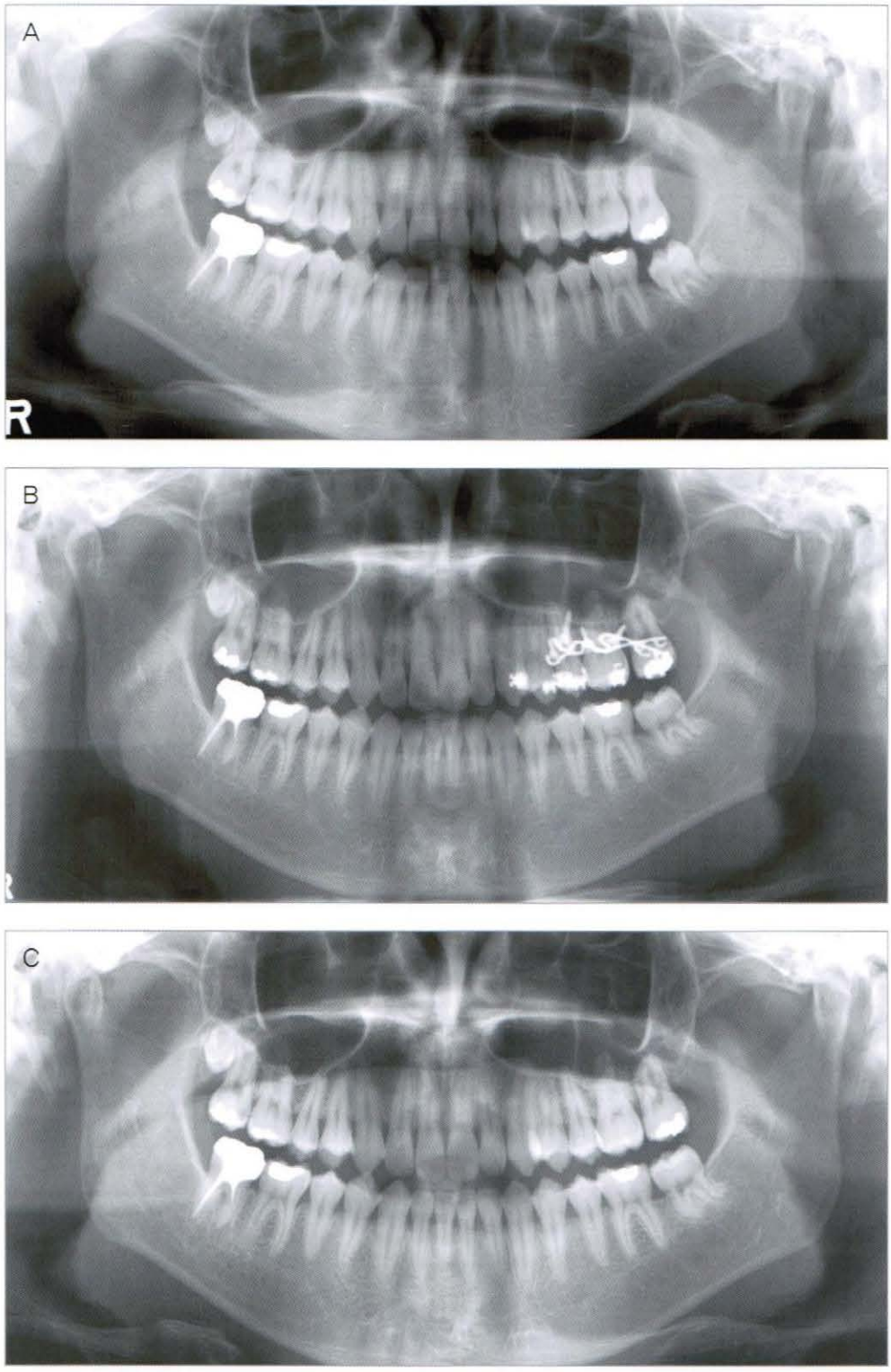


Figure 8-5-9. Treatment progress
A. Pre-treatment panoramic radiograph
B. 6 months after intrusion (2006. 8.9). With intrusion of the upper second molar, the lower third molar has erupted naturally. Space mesial to the third molar has closed with mesial movement of the tooth. The upper second molar has intruded with some distal movement, and caused spacing between the first and second molar. This was closed by placing power chain to the most mesial hook.
C. Debonding after 10 months of intrusion (2006. 12.13)

Figure 8-5-10. Intraoral photograph at debonding (2006. 12.13)
The occlusion of the rest of the teeth was maintained well.

■ Case 19 (Figure 8-6-1 to 9)

- Age : 56 years 10 months
- Sex : female
- Chief complaint : extrusion of upper right second molar

Figure 8-6-1. Pre-treatment facial photograph of Case 19 (2005. 4.27)
She shows a good profile.

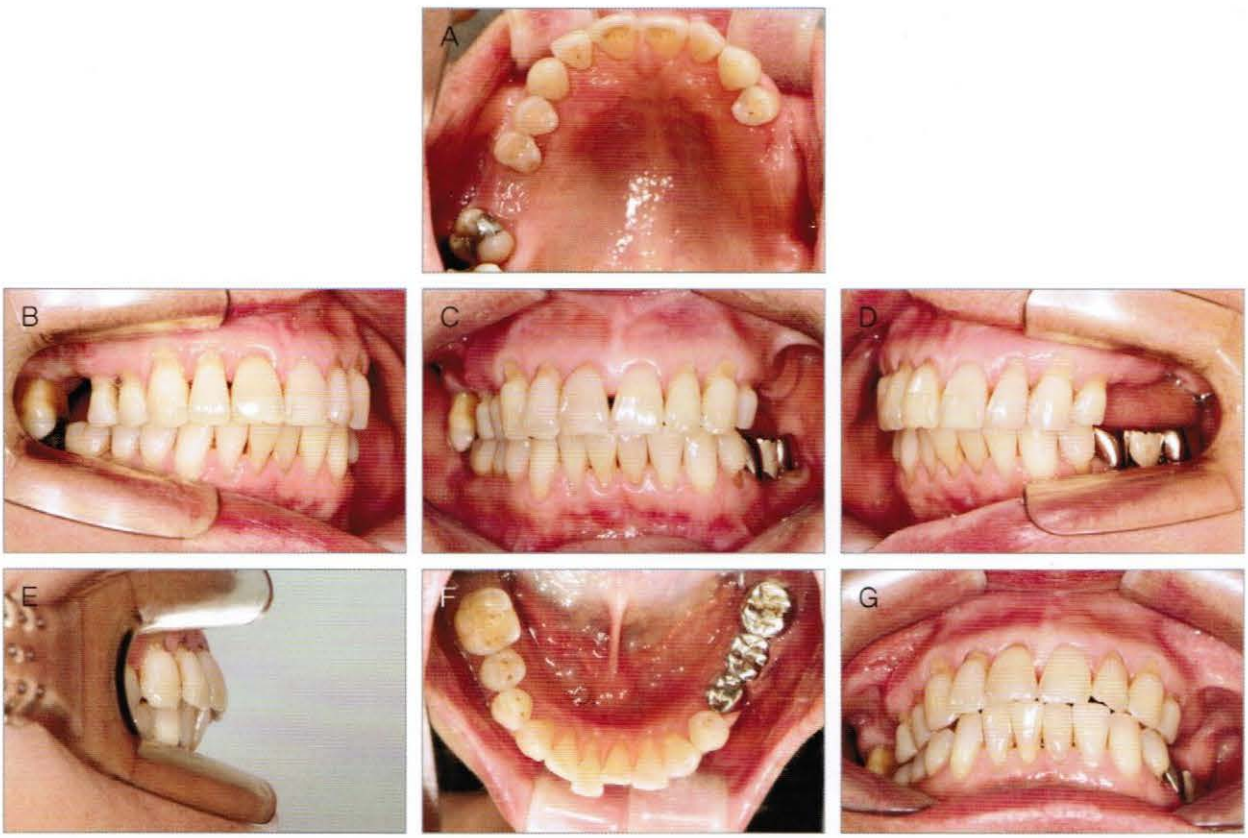


Figure 8-6-2. Pre-treatment intraoral photograph of Case 19 (2005. 4.27)
The upper right second molar is evererupted (B). The patient was referred for intrusion of this tooth from the Prosthodontics department.

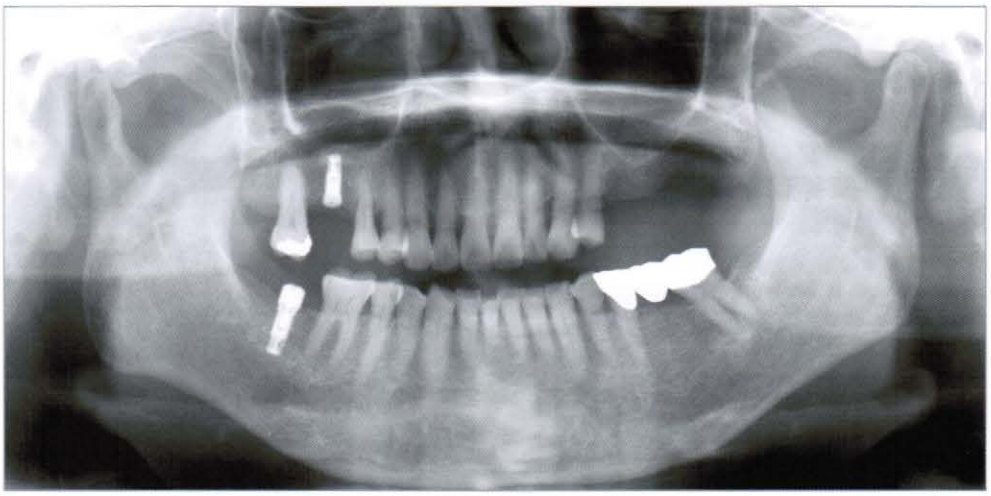
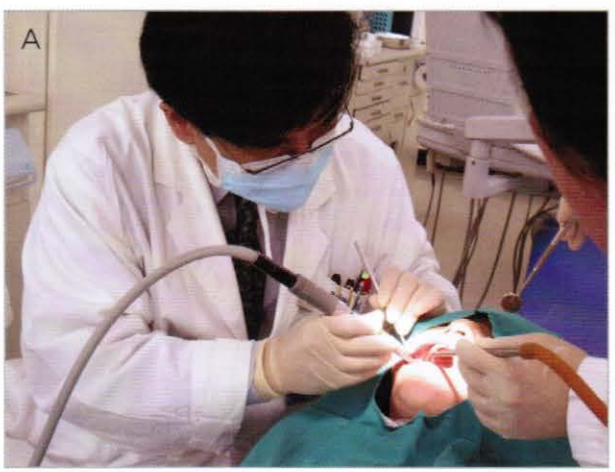


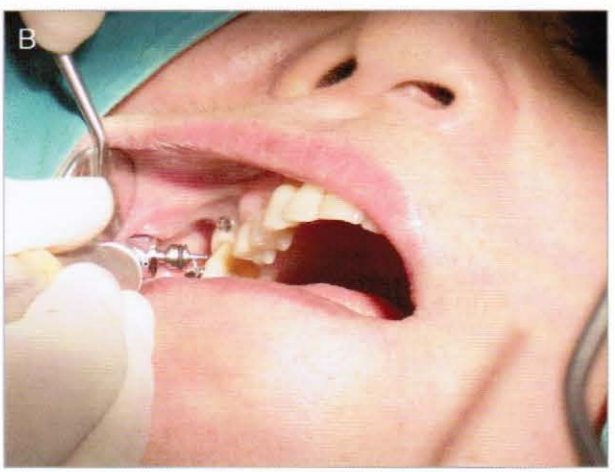
Figure 8-6-3. Panoramic radiograph (2005. 4.1)
Many teeth have been lost due to periodontal disease. The upper right second molar is extruded.

Clinical tip ››››

Edentulous ridge and maxillary tuberosity (Figure 8-6-3, Figure 8-6-4D)

There are times when the bone is very soft. Probe the soft tissue and bone with an explorer before mini-implant insertion to estimate their thickness.





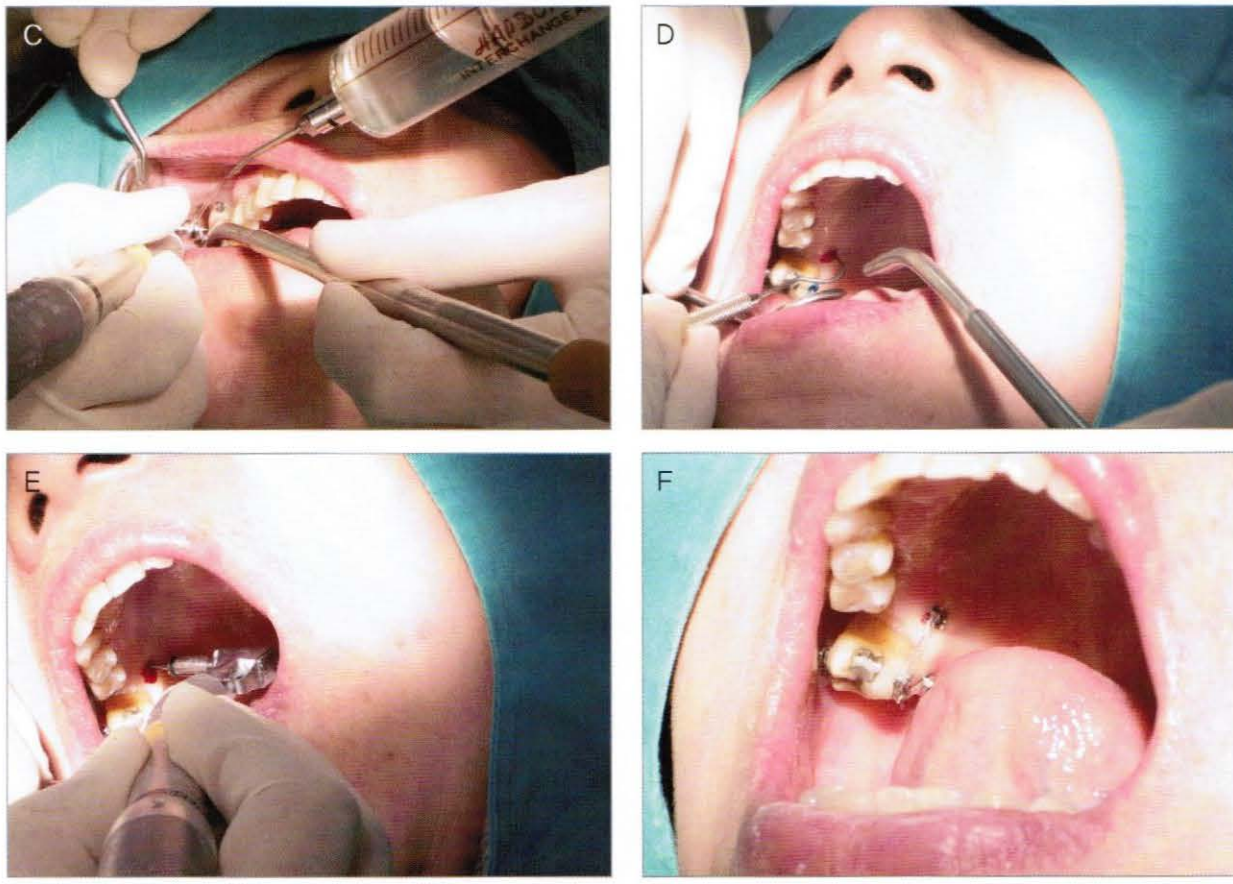


Figure 8-6-4. Implantation procedure (2005. 5.25)
A. Photograph of the author during mini-implant insertion
B. A mini-implant is being inserted distal to the second molar. An angle handpiece and bur-type wrench (113-MJ-203) is being used due to the narrow space.
C. Saline was irrigated to minimize heat.
D. The thickness of soft tissue must be checked especially when implanting in the palate. Quality of bone of the edentulous ridge is also checked with an explorer. A long mini-implant is used to increase stability.
E. A long bur-type wrench (113-MD-204) is used in an implant angle handpiece. A 1.6×8mm mini-implant was used.
F. After implantation, power chain was placed immediately to commence intrusion.

Treatment Progress

- **Implantation Intrusion of upper second molars** — 7 months
  - 2005. 5.25 ~ 12.23 Buccal 1.6×6.0 2EA ⏐7⏐
    Palatal 1.6×8.0 2EA ⏐7⏐
    + power chains
  - 2005. 12.23 Steel ligation for retention
- **Debonding**
  - 2006. 3.3 Debonding

A total of 7 months of intrusion was attempted. Tight steel ligation was used for retention.

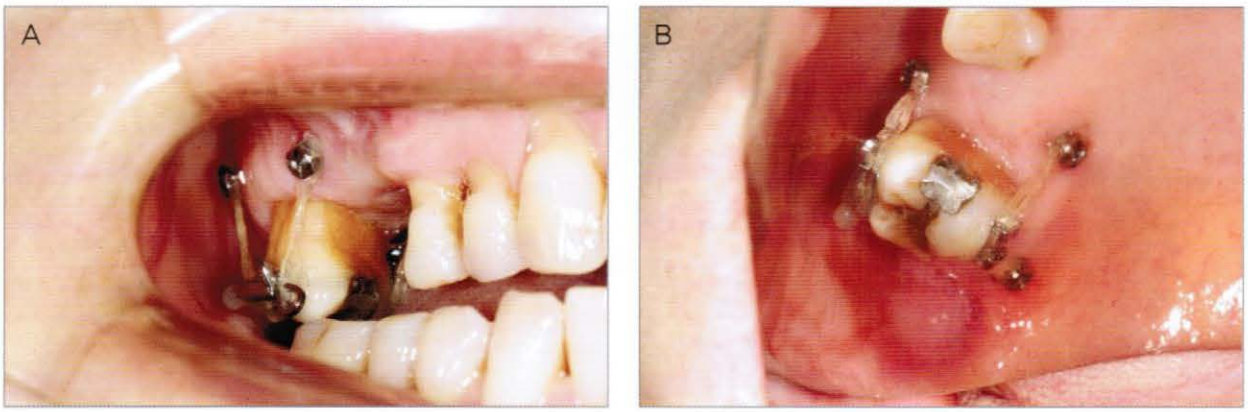
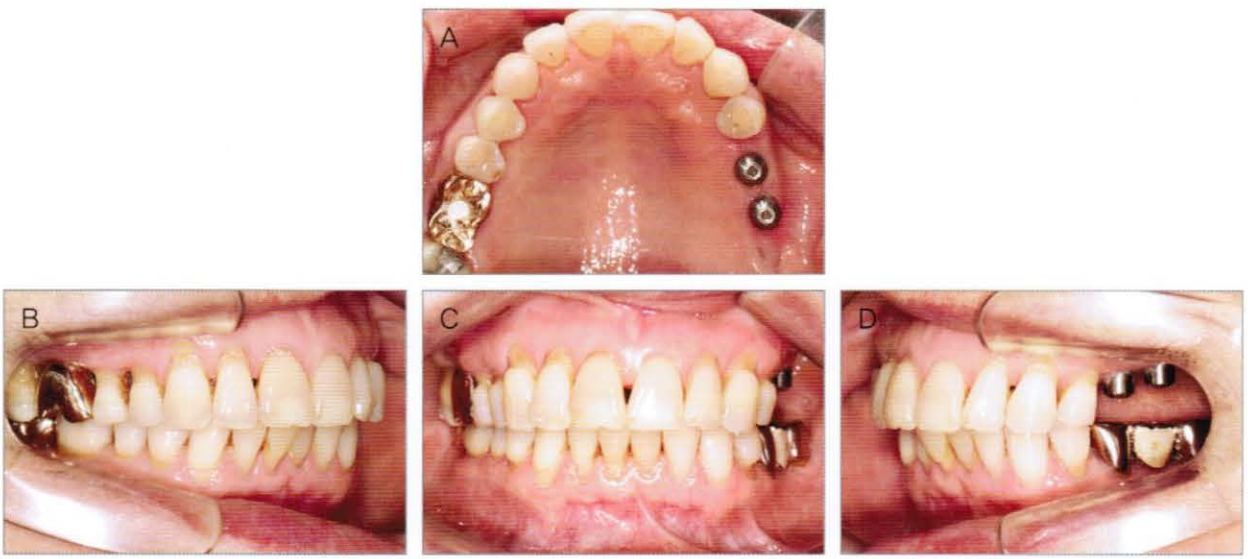


Figure 8-6-5. Intrusion mechanics (2005. 5.27)
Because 4 points of activation are possible on the tooth, force direction can be adjusted easily.

Figure 8-6-6. After completion of intrusion (2006. 3.3)
After 7 months of intrusion, tight steel ligation was used for retention. There was no mobility of the mesio-buccal mini-implant, but as bone resorption progressed, more of the mini-implant became exposed to the oral cavity.



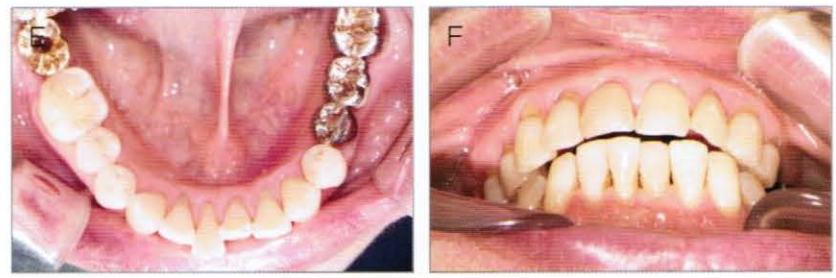


Figure 8-6-7. Intraoral photograph after debonding and prosthodontic treatment (2006. 3.21)
Slight anterior open bite occurred after prosthodontic treatment. It cannot be said for sure whether this open bite occurred due to relapse of the upper molar, or whether it occurred during prosthodontic treatment. She needs regular follow-up care.

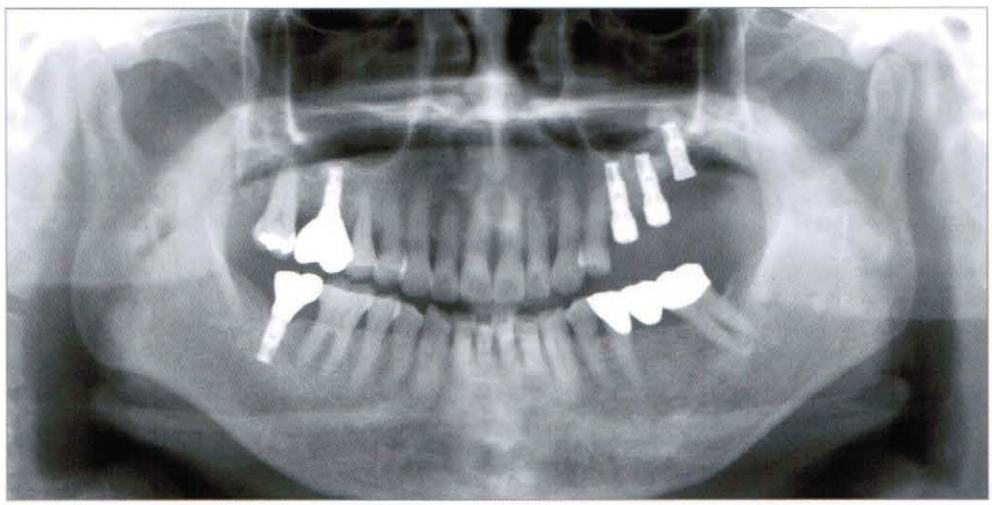


Figure 8-6-8. Panoramic radiograph after placement of crown on the lower right second molar (2006. 3.21)
After fitting of the lower right second molar crown, all orthodontic appliances were removed.

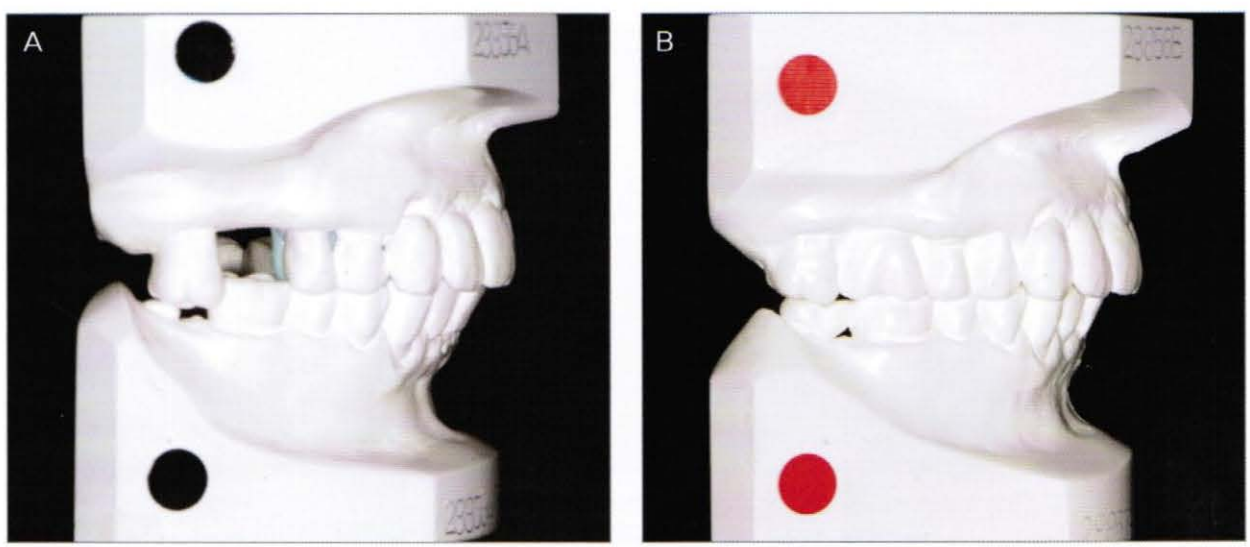


Figure 8-6-9. Comparison of pre- and post-treatment study model
A. There is overeruption of the upper right second molar pre-treatment.
B. Study model after all treatment was finished. A large amount of intrusion has occurred.

Ⅴ. Intrusion and uprighting of lower molar

Lower molar intrusion is very difficult. There are limitations since mini-implants cannot be inserted on the lingual side of the lower molar. This is a case where molar uprighting and intrusion was attempted.

■ Case 20 (Figure 8-7-1 to 13)

- Age : 28 years 2 months
- Sex : female
- Chief complaint : square jaw, mesially tilted lower right second molar

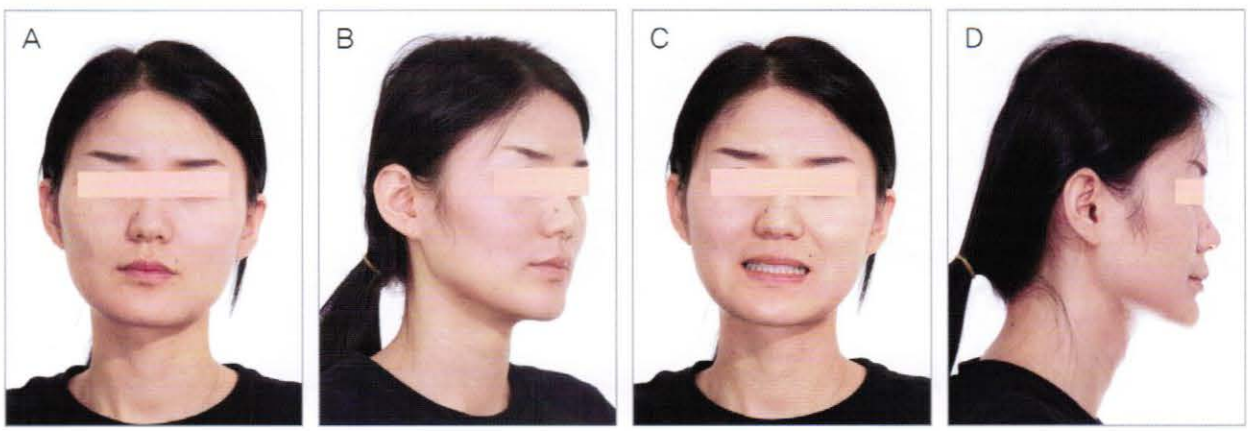


Figure 8-7-1. Pre-treatment facial photograph of Case 20 (2005. 8.19)
She complained of having a square jaw because the gonial angle area was prominent.

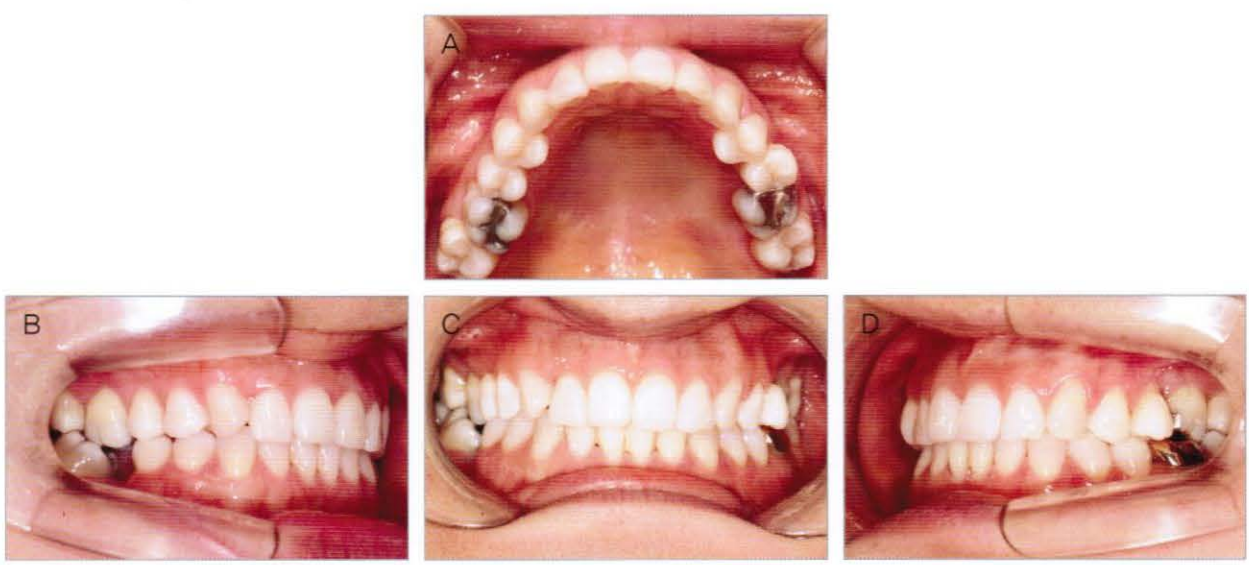


Figure 8-7-2. Pre-treatment intraoral photograph of Case 20 (2005. 8.19)
The lower right second molar is mesially tilted due to a missing first molar. This has also caused overeruption of the upper right first molar. There is slight crowding, but the patient did not want full orthodontic treatment.

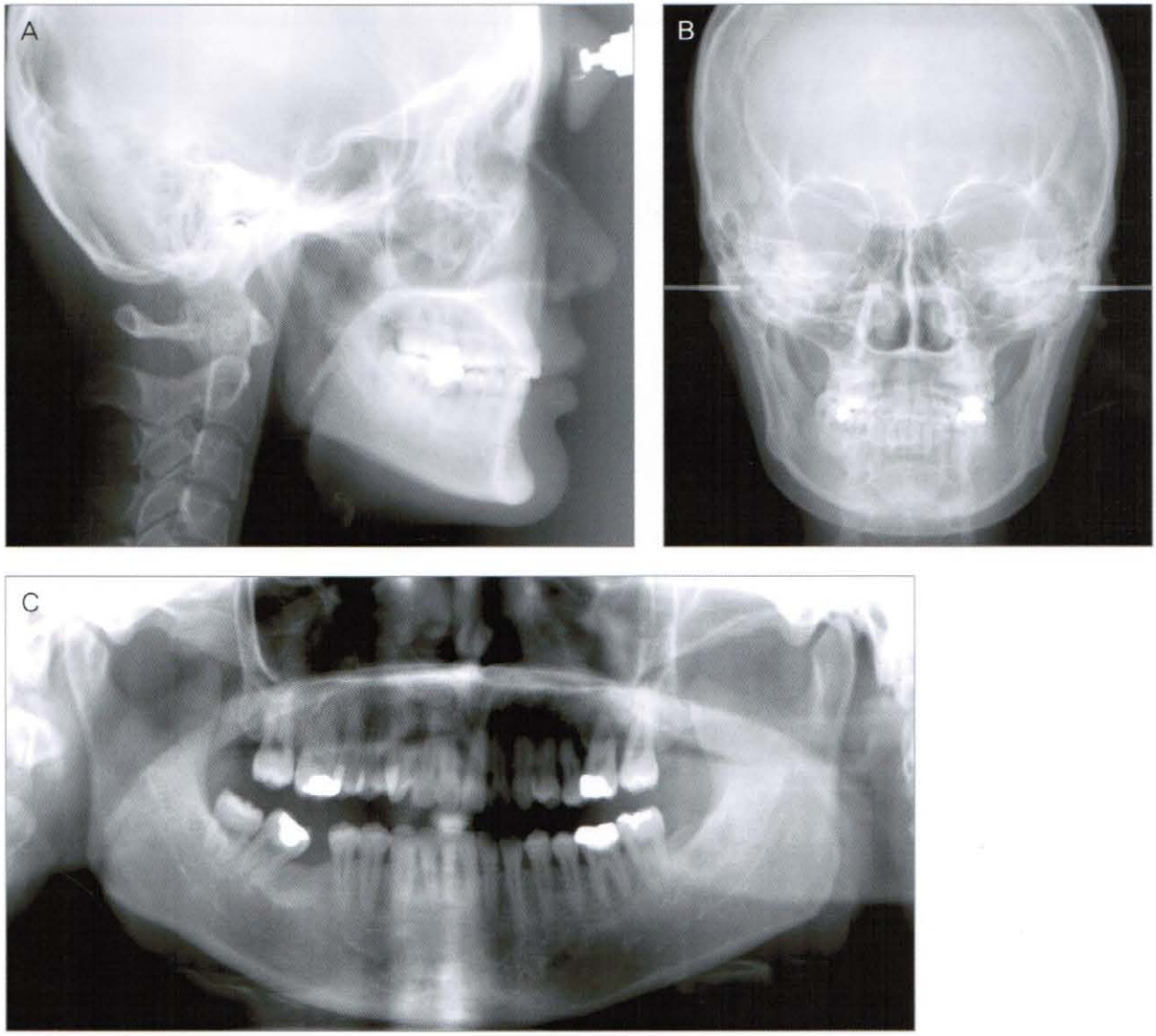


Figure 8-7-3. Pre-treatment cephalometric radiograph (A), postero-anterior radiograph (B), and panoramic radiograph (C) (2005. 8.19)
A. She shows a normal skeletal pattern, profile and dentition
B. Both sides are symmetrical
C. The upper right first molar is overerupted. The lower right second molar is mesially tilted.

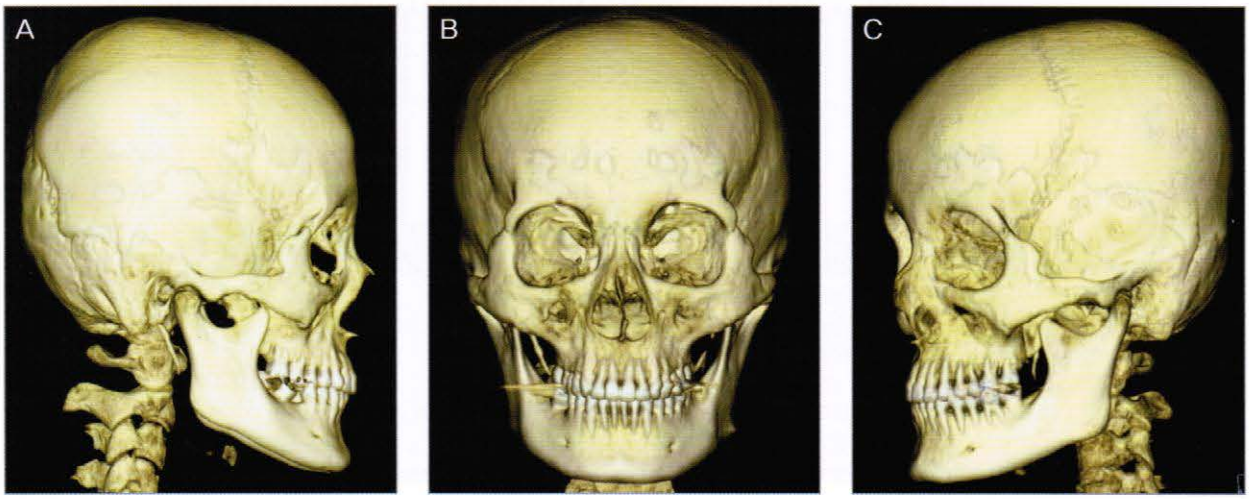


Figure 8-7-4. 3D CT taken for gonial shaving (2005. 8.19)

Treatment Progress

- **Gonial shaving**
  - 2005. 10.7 Gonial shaving
- **Preparation**
  - 2005. 12.8 Extraction of lower right third molar
  - 2006. 5.18 Lower 5-to-5 fixed retainer
- **Implantation, Intrusion of upper molars & uprighting of lower second molar**
  - 2006. 6.7 Upper Buccal 1.6×6.0 2EA $\underline{6\downarrow 5\downarrow 4}$
    Palatal 1.6×8.0 2EA $\underline{6\downarrow 5\downarrow 4}$
    Lower Buccal 1.6×6.0 1EA $\overline{7\uparrow 5}$
  - 2006. 6.16 Bracket bonding on the lower mini-implant
  - 2006. 6.26 018″ ss on $\underline{76}$
    Two 0.9mm bars bonded to the upper mini-implants & power chains
    017×025″ TMA uprighting spring on the lower right second molar
  - 2006. 11.7 A new uprighting spring because of cheek mucosa irritation
  - 2007. 3.14 Stop the intrusion force and let the upper right molars extrude
  - 2007. 4.11 Bonding bracket on $\overline{5\ 4}$ & 018×025″ ss with closed coil
- **Debonding**
  - 2007. 4.25 Removal of fixed retainer and mini-implants
  - 2008. 1.22 Debonding
  - 2008. 2.13 Setting the crown on the implant (#46)

The patient's main complaint of a square jaw was treated through gonial shaving surgery. After surgery, a fixed retainer was bonded lingually between the lower premolar to premolar. Overeruption of the upper

right molar prevented uprighting of the lower right second molar. Also during uprighting of the lower right second molar, the tooth can act as a wedge to cause open bite. Therefore 2 buccal and 2 palatal mini-implants were inserted for intrusion of the upper right molar. A 0.9mm bar was bonded to these mini-implants to allow for sufficient intrusion. After uprighting of the lower right second molar, the upper molar was allowed to extrude slightly for interdigitation. For uprighting of the lower right second molar, 022" MBT bracket was bonded onto the mini-implant head and used as anchorage. Uprighting was carried out through 017x025" TMA T-loop. Because the L-loop was causing discomfort for the patient buccally, the position of the loop was changed to sit in the extraction space of the first molar. Total treatment took longer than planned because the patient did not attend for the birth of her baby. Treatment was finished well without adverse effects on the rest of the teeth which were not bonded.

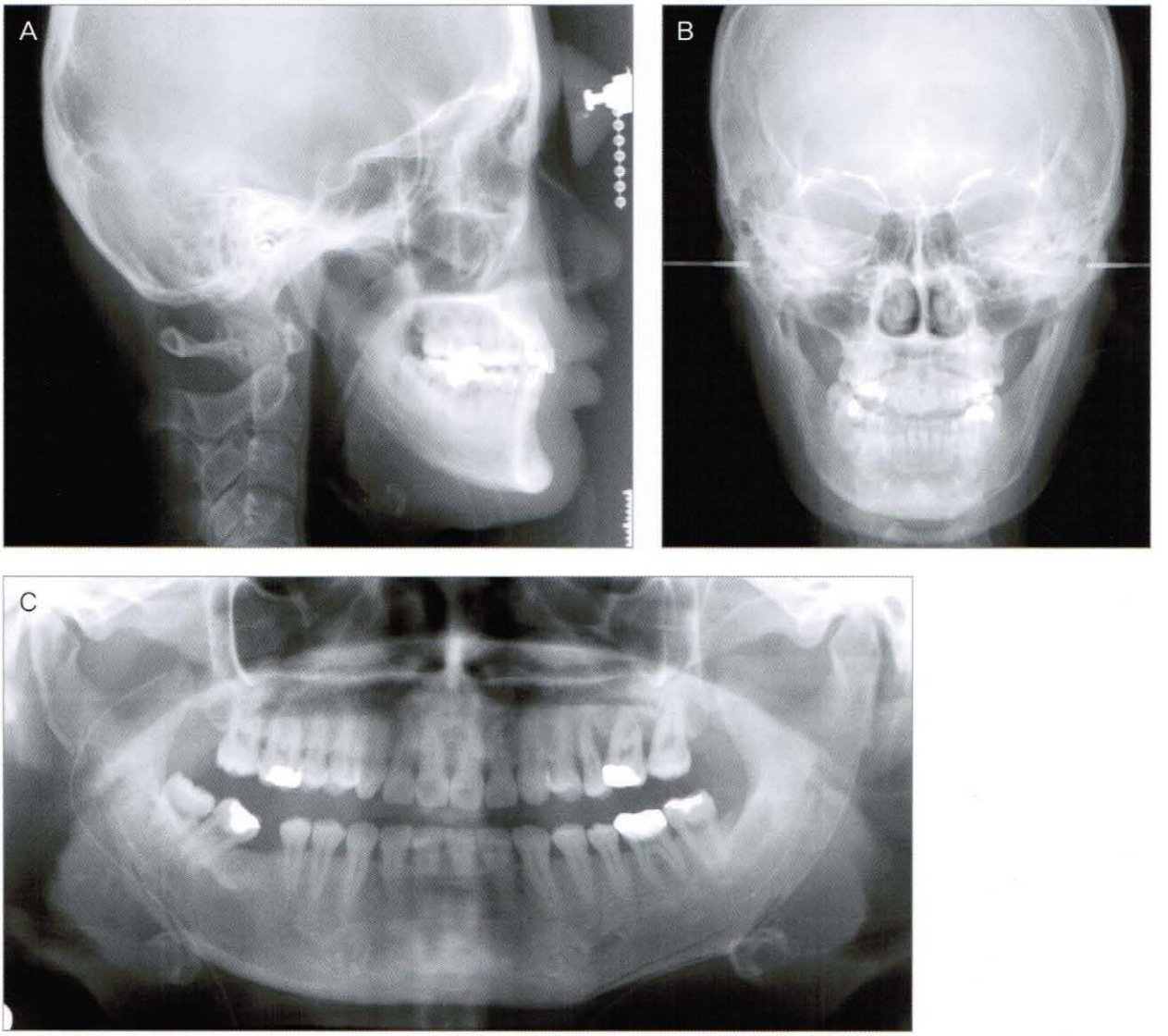


Figure 8-7-5. Cephalometric radiograph (A), postero-anterior radiograph (B) and panoramic radiograph (C) taken after surgery (2005. 10.7)
A. After gonial angle shaving.
B. The mandible looks a lot thinner.
C. Change in contour can be seen due to gonial angle shaving.

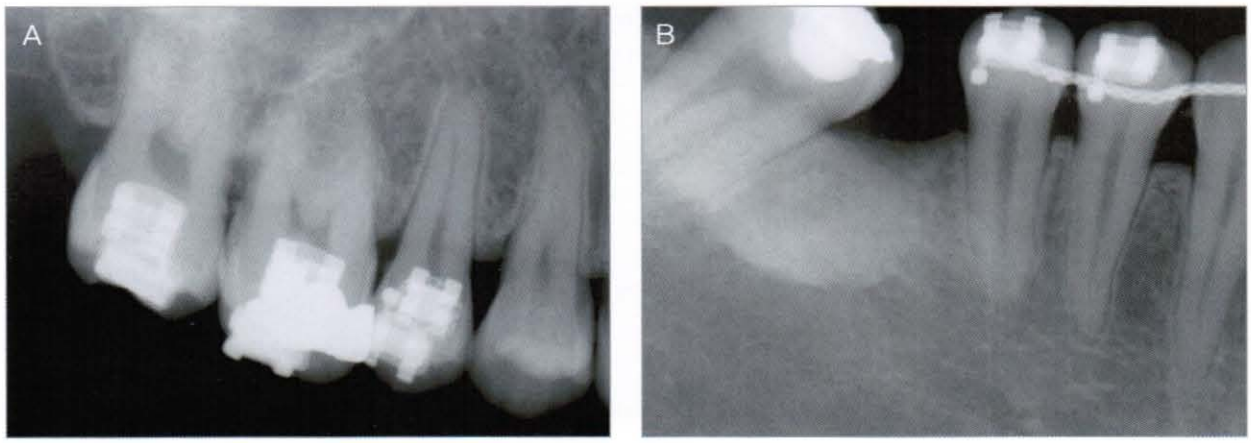


Figure 8-7-6. Periapical radiograph taken to visualize interradicular distances for mini-implant insertion (2006. 5.23)
A. The interradicular distances between the upper right first and second premolar, and between the second premolar and first molar are wide.
B. In the mandible, it was decided to implant in the first molar extraction space.

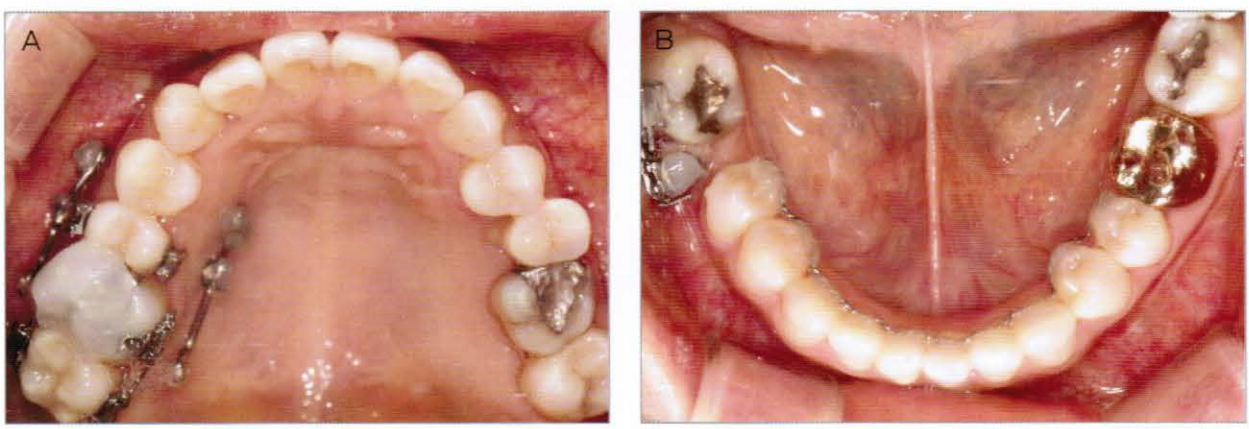


Figure 8-7-7. Intraoral photograph taken with upper and lower appliances in place (2006. 6.27)
A. Mechanism for intrusion of extruded upper right first and second molars
Mini-implants were inserted between the first and second premolars and between the second premolar and first molar buccally (1.6×6mm) and palatally (1.6×8mm). 0.9mm wire was bent so that hooks were placed between the first and second molar and bonded onto the mini-implant heads with resin. Power chain was placed between the hooks and first molar for intrusion. Mini-implant heads were sandblasted for increased retention. 018″ ss wire was ligated. It is unfortunate that utility wax was left on the occlusal surface of the upper first molar to make the appliance not visible.
B. Fixed retainer was placed between the lower second premolar to second premolar. This prevented the first molar from being tilted into the extraction space. A 1.6×8mm mini-implant was inserted in the first molar space and a premolar MBT bracket bonded onto the head. 017×025″ TMA was ligated onto this bracket for uprighting of the lower second molar.

Figure 8-7-8. Five months into treatment (2006. 11.7)
A. Upper molar intrusion is progressing. Some distal driving has occurred with intrusion.
B. Lower second molar has uprighted, and the loop has been placed into the extraction space. This has decreased discomfort for the patient.
C. Open bite has occurred in the molar area. After uprighting of the lower second molar, the upper molar has been allowed to extrude to allow interdigitation.

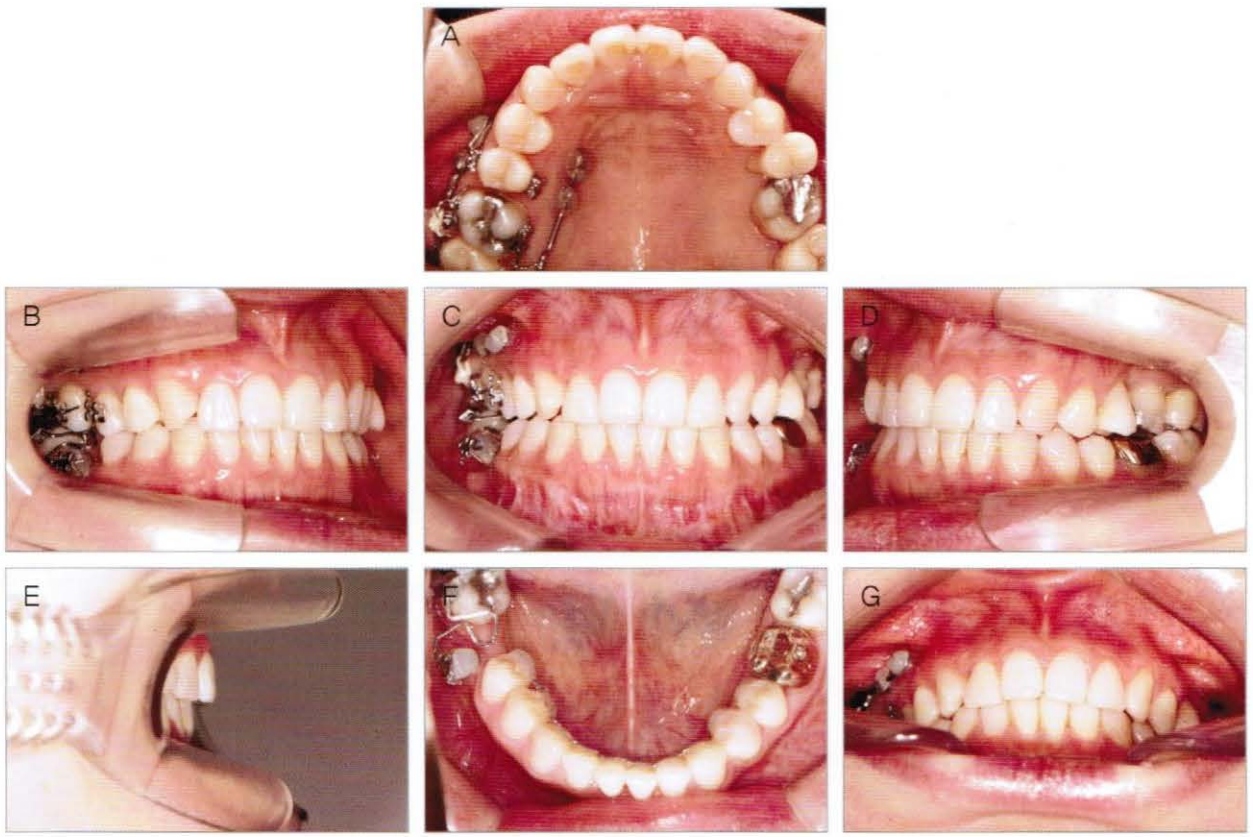


Figure 8-7-9. Eight months into treatment (2007. 2.22)
Steel ligature has been ligated in the palate. Intrusion has been stopped (A). Occlusion in the rest of the mouth has been maintained well. The temporary open bite has decreased (B).

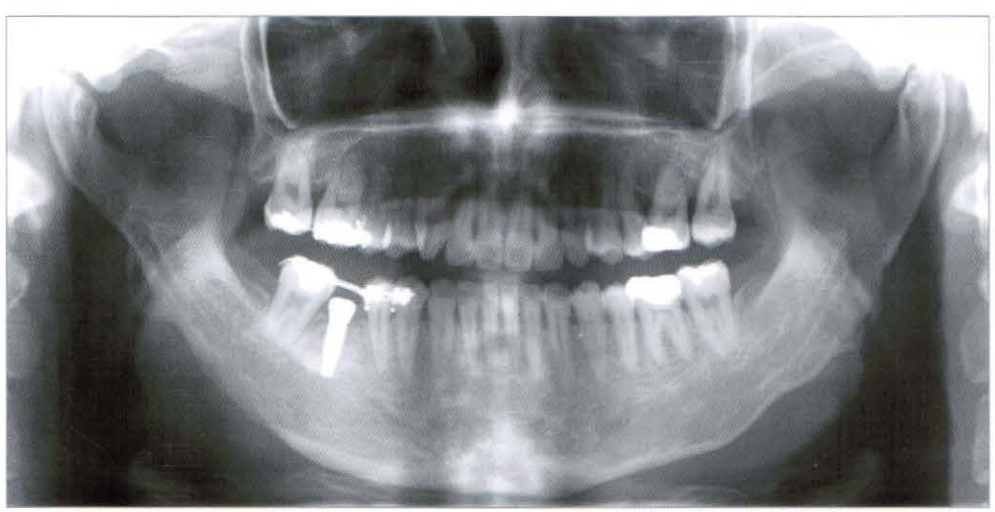


Figure 8-7-10. One year 4 months after treatment (2007. 10.19)
The lower fixed retainer and mini-implant have been removed (2007. 4.25). Brackets were bonded on the lower first and second premolar, with closed coil spring used to retain space. It was left this way for 10 months during the patient's pregnancy. A dental implant is in place in the lower right first molar space.

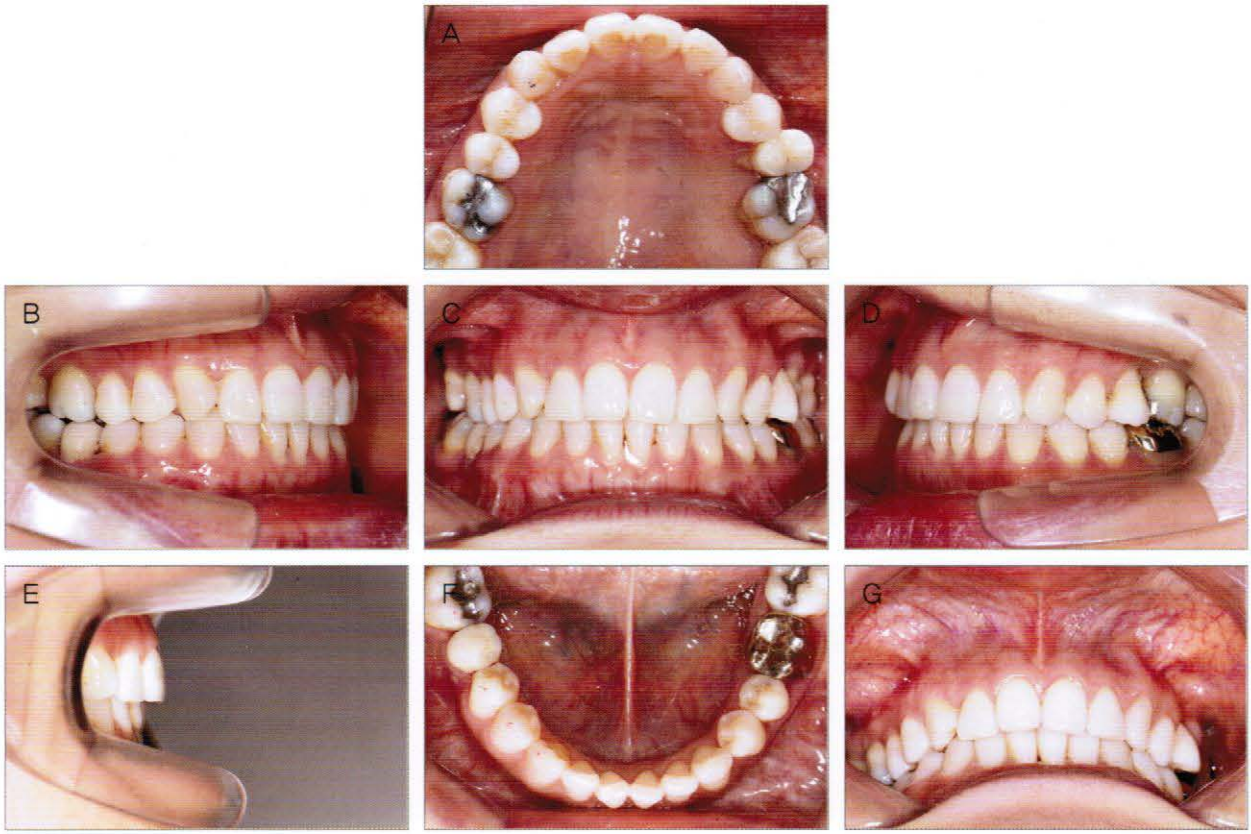


Figure 8-7-11. Intraoral photograph at debonding (2008. 2.13)
All the teeth occlude the same as pre-treatment. A small crown has been placed in the first molar implant.

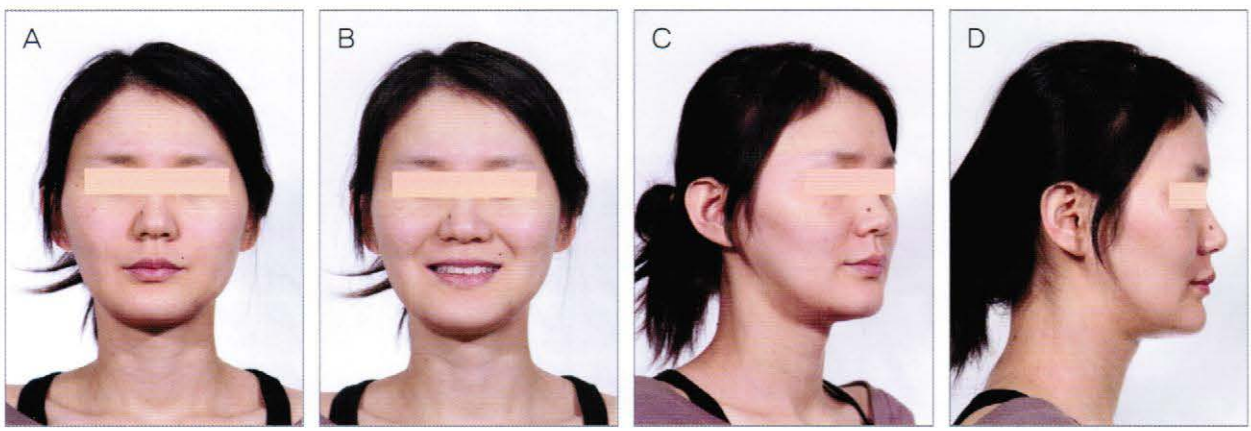


Figure 8-7-12. Facial photograph at debonding (2008. 2.13)

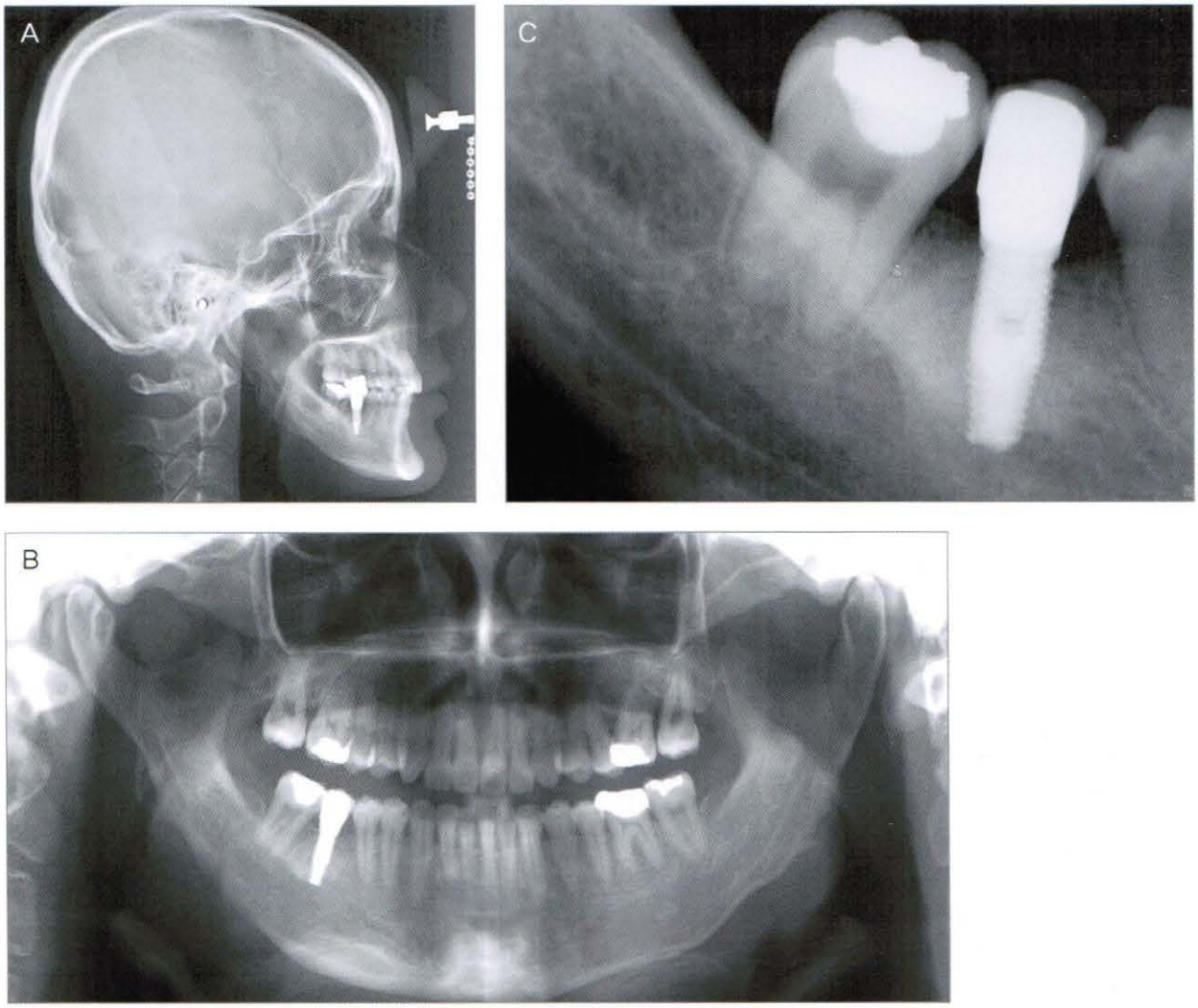


Figure 8-7-13. Cephalometric radiograph (A), panoramic radiograph (B), and periapical radiograph (C) at debonding (2008. 5.23)

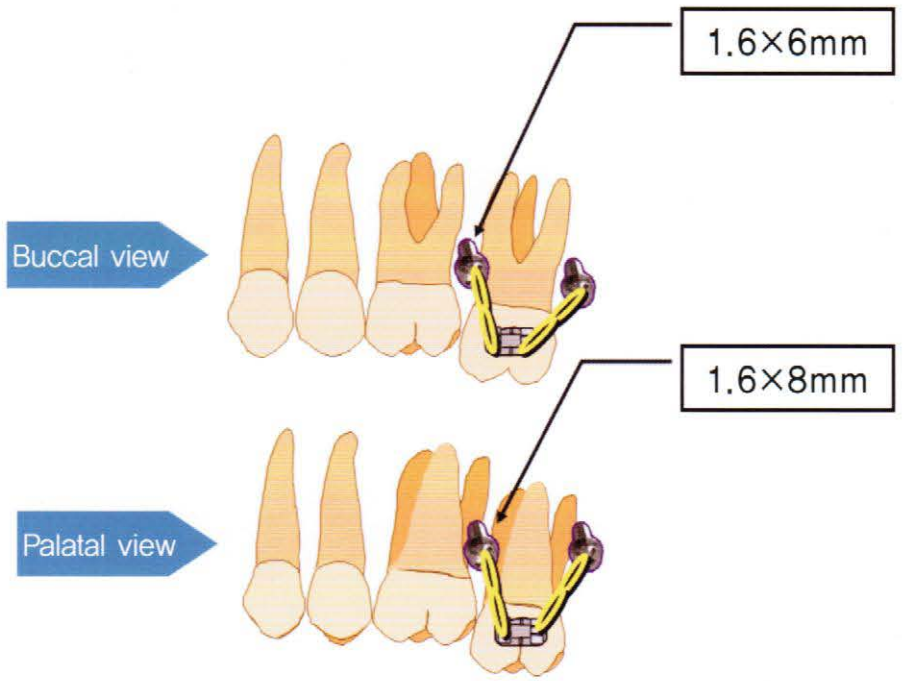
Ⅵ. Various methods to intrude extruded molars

Five methods for intrusion of molars (Method 1~5) and one method for lower molar intrusion (Method 6) is introduced.

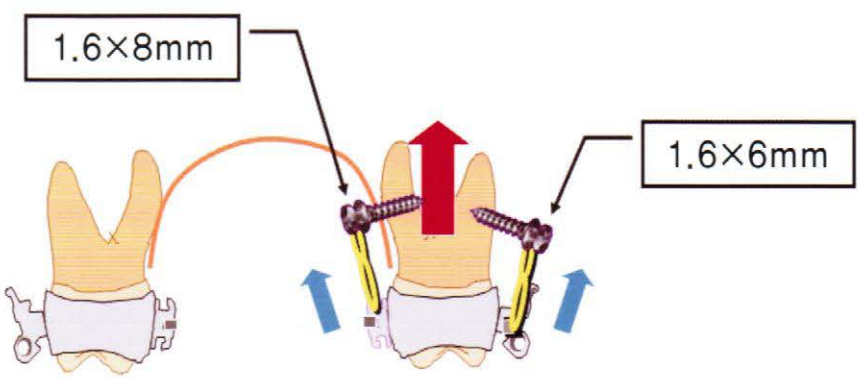
Molar intrusion method (Method 1~5)

Method 1

A



B



■ Mini-implants

- Buccal ;
  - 1.6 × 6.0 between 6 and 7
  - 1.6 × 6.0 distal to 7
- Palatal ;
  - 1.6 × 8.0 between 6 and 7
  - 1.6 × 8.0 distal to 7

■ Brackets

- Buccal & Palatal ; 018″ Standard braket or lingual button

Advantages

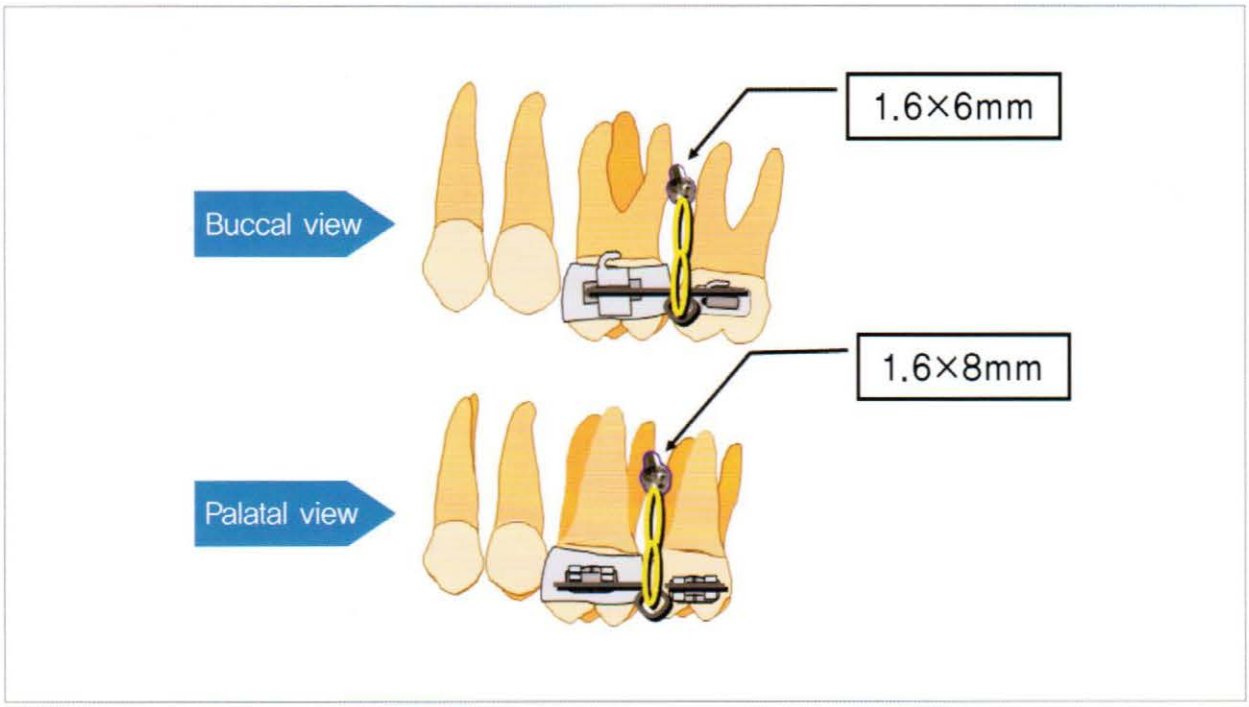
- Easy to control the bucco-lingual and mesio-distal inclination

Disadvantages

- Hard to find good indications
  - There are not many cases where the interradicular distances between the upper first and second molars are wide enough.
  - There must be ample space in the maxillary tuberosity behind the second molar to be able to insert a mini-implant in this area. The bone must be dense enough. There are cases where the explorer is pushed straight into the bone when probed. In these cases, there is high possibility of failure.

- Buccal screws fail frequently as the posterior teeth intrude.
  - As the molars intrude, the mini-implant becomes closer to the alveolar crest and root surface, and failure may occur more easily.

Method 2



- Mini-implants
  - Buccal : 1.6×6.0 between 6 and 7
  - Palatal : 1.6×8.0 between 6 and 7
- Brackets
  - Buccal : 022″ MBT
  - Palatal : 018″ Standard wide brackets on 6 & 7
- Wires
  - Buccal 018×025 ss or heavier
  - Palatal 016×022 ss or heavier

Advantages

- Easy to control the bucco-lingual inclination
- Easy to control mesio-distally
- Useful for intrusion of two adjacent molars

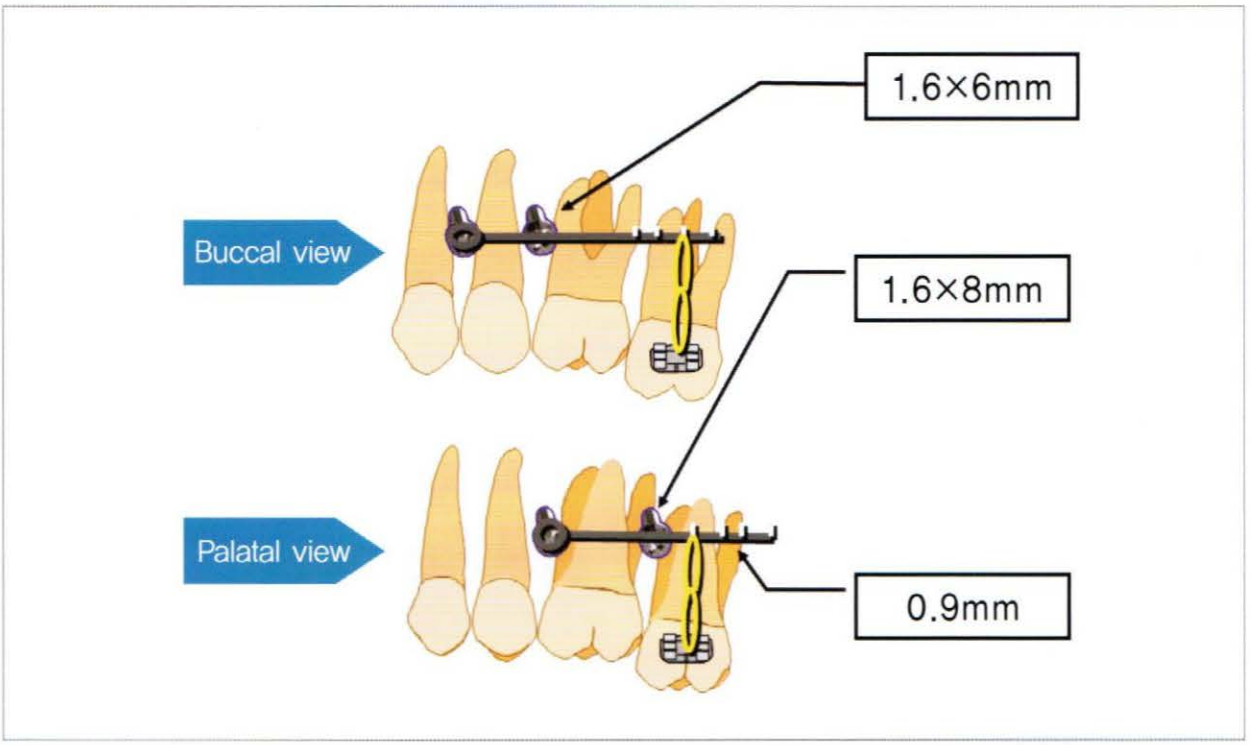
Disadvantages

- Hard to find good indications
  - There are not many cases where the interradicular space between the upper first and second molar is wide enough.

■ Buccal screws fail frequently as the posterior teeth intrude.

• As the molars intrude, the mini-implant becomes closer to the alveolar crest and root surface, and failure may occur more easily.

Method 3



■ Mini-implants

■ Buccal ;

• 1.6 × 6.0 between 4 and 5

• 1.6 × 6.0 between 5 and 6

■ Palatal ;

• 1.6 × 8.0 between 5 and 6

• 1.6 × 8.0 between 6 and 7

■ Brackets

■ Buccal & Palatal 018″ Standard braket or lingual button

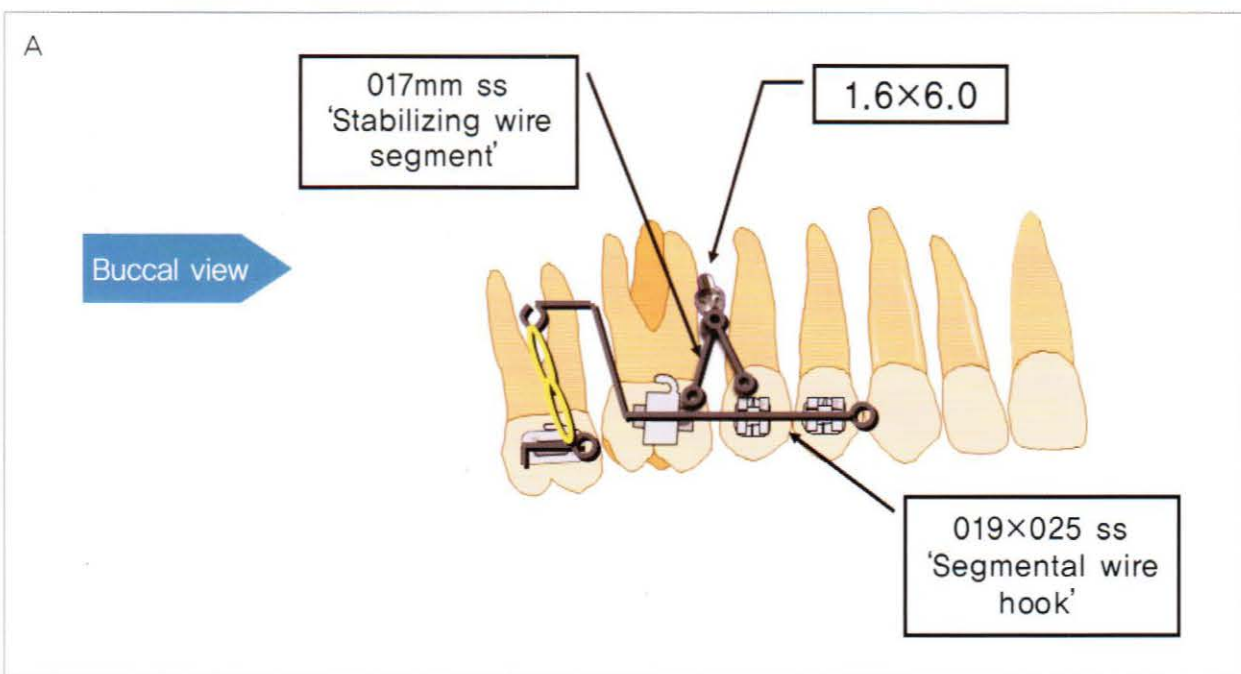
Advantages

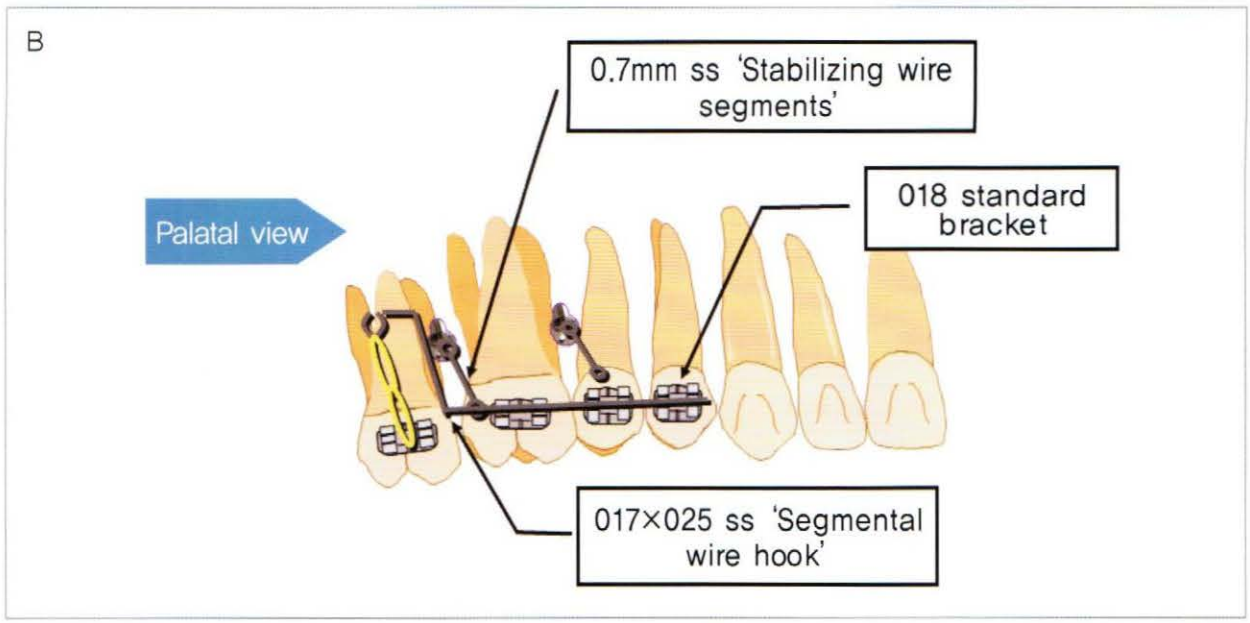
- Easy to control the bucco-lingual and mesio-distal inclination
- Can avoid the narrow buccal interradicular space between 6 and 7, which may reduce the failure rate.

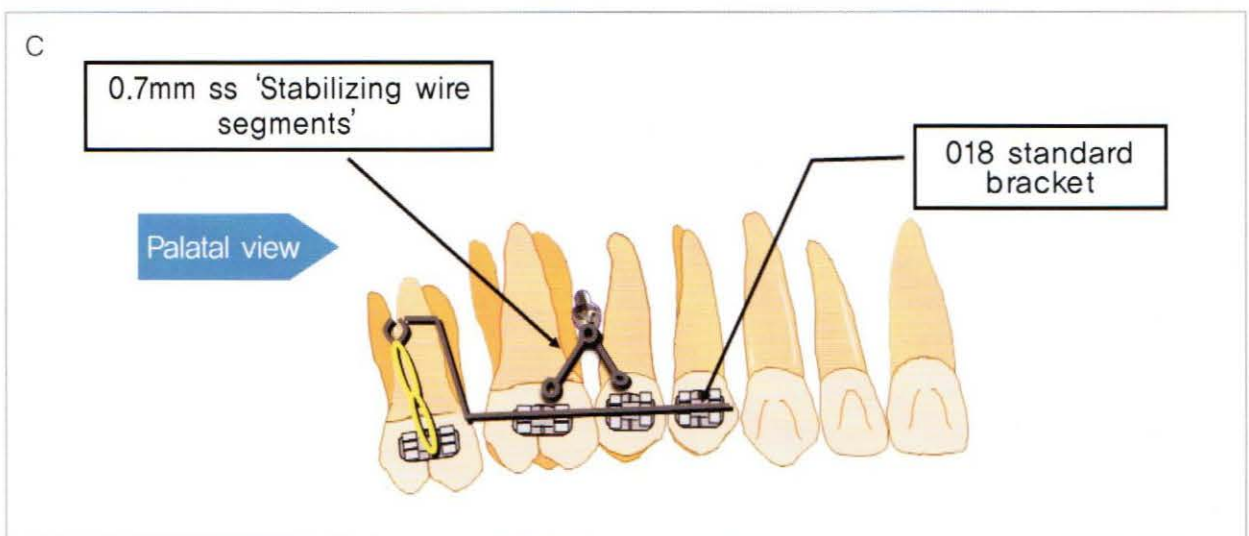
Disadvantages

- Can not easily change or adjust the bonded bars.
  - Because the 0.9mm ss bar is bonded with resin, adjustment is not possible. Therefore many hooks must be placed in the wire to be able to adjust the direction of intrusion.
- Needs four interradicular mini-implants
  - The need for four mini-implants can be a burden.

Method 4







■ Mini-implants

- Buccal 1.6×6.0 between 5 and 6
- Palatal 1.6×8.0 between 5 and 6
  between 6 and 7 (B)
  or Palatal 1.6×8.0 between 5 and 6 (C)

■ Brackets

- Buccal : 022″ MBT
- Palatal : 018″ Standard
  - Wide brackets on 6 & 7
  - Medium brackets on 4 & 5

- Stabilizing wire segments
  - 0.7mm ss
- Segmental wire hooks
  - Buccal 019×025 ss or heavier
  - Palatal 017×025 ss or heavier

Advantages

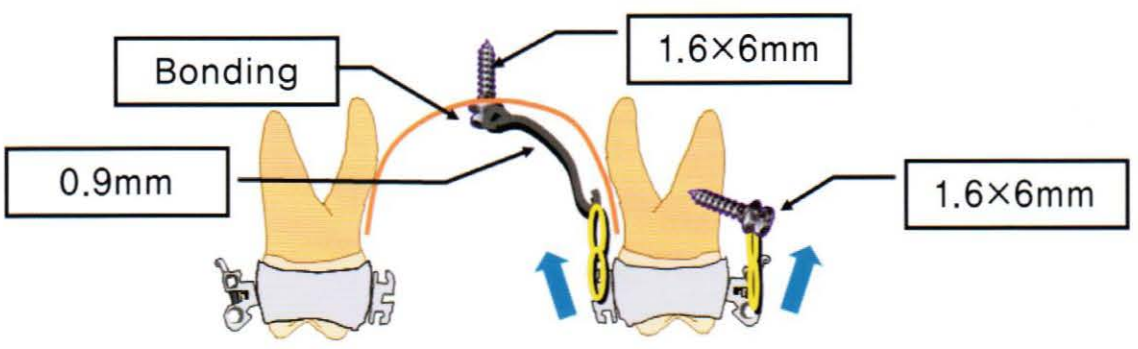
- Easy to control the bucco-lingual inclination and mesio-distal movements
- May change or modify the 'Segmental wire hooks'
  - The wire may be changed at any time.
- Only two mini-implants are needed.
  - Less mini-implants than Method 3 are used.
- Method of choice
  - The author enjoys using this method.

Disadvantages

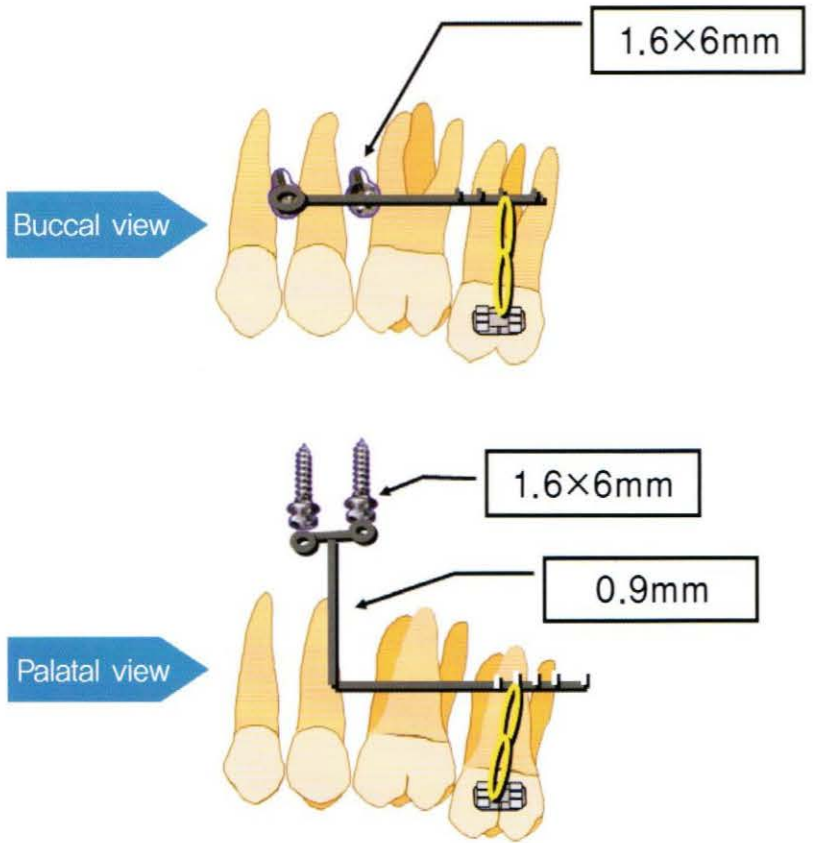
- Difficult to bend the 'Segmental wire hooks'
  - It is difficult to ligate the wire totally passive into the brackets.

Method 5

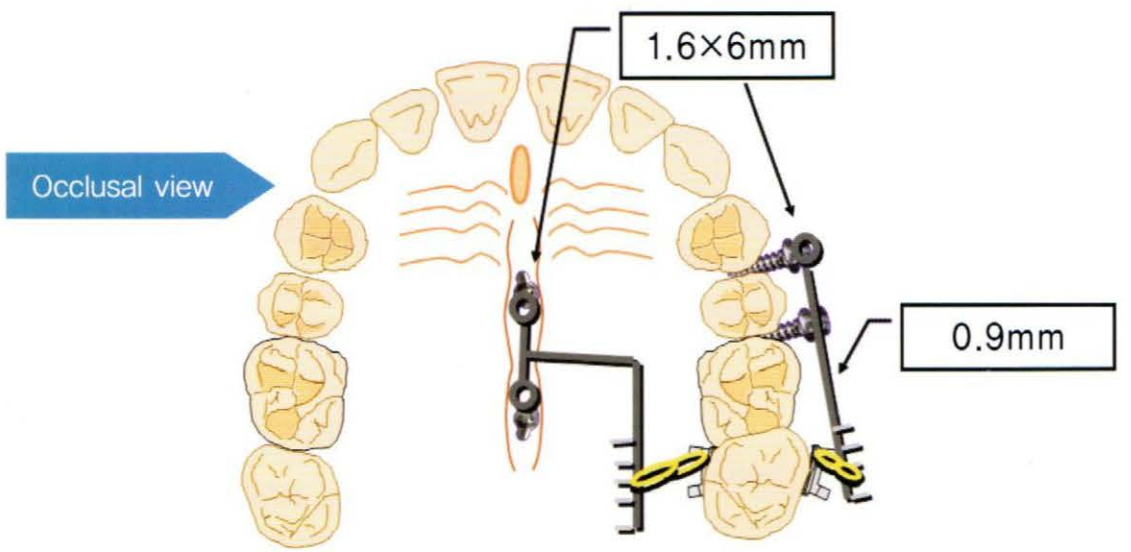
A



B


1.6×6mm
Buccal view
1.6×6mm
0.9mm
Palatal view

C


1.6×6mm
Occlusal view
0.9mm

■ Mini-implants
- Buccal ;
  - 1.6 × 6.0 between 4 and 5
  - 1.6 × 6.0 between 5 and 6
- Mid-palatal ;
  - 1.6 × 6.0 at 4 or 5
  - 1.6 × 6.0 between 6 and 7

■ Bar with hooks
- 0.9mm

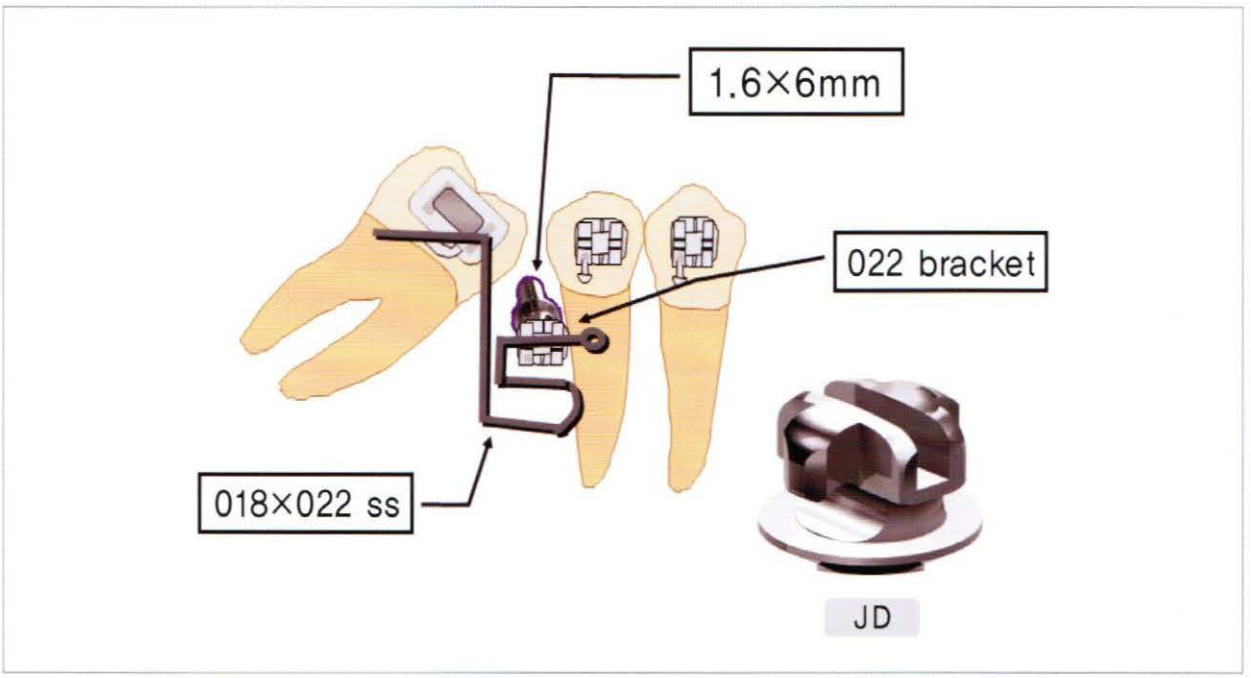
■ Brackets
- Buccal & Palatal : 018″ Standard bracket or lingual button

Advantages
- Easy to control the direction of traction (mesio-distal & bucco-lingual)
  - Many hooks can be placed beforehand to adjust the direction of intrusion.
- Can avoid the narrow buccal interradicular space between 6 and 7, which can reduce the failure rate
- Mid-palatal mini-implant is very stable and easily implanted.

Disadvantages
- Can not easily change or adjust the 'Segmental wire hooks'.
- Needs the implant angle and bur-type wrench.
  - To implant in the mid-palatal area, extra instruments are required.
- Irritation to tongue
  - Irritation to tongue causes much discomfort.

Lower molar intrusion method (Method 6)

Method 6



- Mini-implants
  - Buccal ;
    - 1.6 × 8.0 between 5 and 7
- Brackets
  - Buccal & Palatal: 018″ Standard bracket or 022″ MBT bracket
    - Resin is bonded onto the mini-implant head. Or a JD type mini-implant is used.
- Wire
  - 017×025″ or 018×025″ TMA

Advantages

- No force is applied to the other teeth.

Disadvantages

- Wire bending is very difficult.

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